MALAYAN AGRICULTURE

HANDBOOK

COMPILED BY

THE

DEPARTMENT OF AGRICULTURE

F.M.S. AND S.S.

BRITISH EMPIRE EXHIBITION

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Price One Shilling.

PREFACE.

THE information contained in this Handbook was first compiled at the request of the Acting Director of Agriculture, Federated Malay States and Straits Settlements, in connexion with the Agricultural Section of the Malaya-Borneo Exhibition, on the occasion of the visit of His Royal Highness the Prince of Wales, K.G., to Malaya; and is now published, in a revised form, for use at the British Empire Exhibition, 1924.

IT is hoped that the information given will serve to stimulate active interest in many new agricultural industries which are suited to the conditions of this country. The possibilities of various local manufacturing industries, based on the raw products of agriculture, should also be kept in view.

G. E. SHAW,

Ag. Secretary for Agriculture,

F.M.S. and S.S.

April, 1924.

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Introduction.

THIS second Edition of the "Handbook of Malayan Agriculture," compiled by the Staff of the Department of Agriculture, F.M.S. and S.S., is intended to draw attention to the various products displayed in the Agriculture Section of the Malaya Pavilion at the British Empire Exhibition, to illustrate the possibilities of new crops, to describe as concisely as possible the best methods of cultivation, harvesting and preparation of these products for the market, and to indicate their market values.

DURING the last fifteen to twenty years, until recently, little attention has been paid to the possibilities of crops in Malaya other than rubber, coconuts and rice. The remarkable rise and progress of the plantation rubber industry which, until the recent slump in prices, has been so successful in Malaya is chiefly responsible for this state of affairs.

THE comparative ease with which the rubber tree can be cultivated in Malaya, compared with the arduous work attached to the cultivation of crops such as sugar-cane and tobacco, is also another responsible factor.

THE cultivation of coconuts on a plantation scale by European Companies or individuals has progressed, but only in a small degree; while the profits obtained,

except by one or two estates, have not been remarkable. The cultivation of padi (rice) is essentially a native holder's proposition.

THESE conditions have resulted in a general lack of precise knowledge of the economic possibilities of other crops which are capable of being grown in the country.

THERE is probably no industry other than agriculture in which the successful production of a marketable product, which will yield a reasonable profit, is dependent on so many unknown factors, such as variations in rainfall, pests and diseases, suitability of soils and fluctuations in the market value of the products. Hence it is desirable to know as closely as possible the costs of production from the time of planting to the placing of the crop on the market, before embarking on a new agricultural industry. Frequently it is not possible to foresee the possibilities of a new crop. The remarkable increase in the consumption of rubber, due especially to the rapid use and development of the motor industry, which has been responsible for the success of the plantation rubber industry, was certainly not foreseen in the early days of rubber planting. There is therefore a large element of speculation in any new agricultural industry and this becomes greater in the case of permanent crops than in the case of annual crops, in which only a year's expenditure may be lost.

THOSE crops which appear to hold out the greatest promise of success are (*a*) oil-yielding crops such as the oil palm and coconuts, (*b*) crops producing sugar, starch or cellulose for the production of industrial alcohol, and (*c*) fibre plants.

THERE is also a number of minor crops, such as plants yielding essential oils, limes for the production of citric acid and related products, kapok for the production of its floss, Derris (tuba) for use as an insecticide, and possibly a number of medicinal plants, including cinchona in particular, coffee, and gutta percha for the production of gutta from the leaf. None of these minor crops, however, can be grown on an extensive scale by all, since the market in most cases is limited.

THERE are also considerable areas in Malaya suitable for the cultivation of sugar-cane, which was formerly grown successfully in the country.

THE principal consideration in connection with the cultivation of sugar-cane is the large amount of capital required for the installation of factory plant and machinery for the preparation of the sugar.

PINEAPPLE cultivation, both by Europeans on a plantation scale and by small holders, again holds out possibilities in view of the revival of the canning industry.

IN addition to dealing with the possibilities of these crops, sections of the Handbook are devoted to the most suitable methods of cultivation on different types of land, problems of diseases and pests, and the application of scientific methods of plant breeding by seed selection or vegetative propagation, which have already been shown to be so successful and essential in the case of sugar-cane, cinchona, cereals and other crops, both in tropical and temperate countries.

It is hoped that the various sections of this Handbook, which contains concise information in respect of many crops which can be grown in Malaya, will direct more attention to their possibilities.

It is not the object of a Handbook of this character to give detailed information on the various crops and their cultivation; such information is obtainable from the Malayan Agricultural Journal, published monthly by the Department of Agriculture, and from special bulletins which are issued from time to time, and can be obtained on application to the Department of Agriculture.

General Cultivation.

General Cultivation.

Soil Cultivation. Agriculture in this country has advanced enormously during the past few years and is now being developed on more scientific lines. The rubber industry in the Peninsula has grown in the last twenty years from a relatively small acreage to a total of approximately one and a quarter million acres. One would naturally expect that methods of soil treatment would have been improved and kept pace with this rapid increase.

THERE is little tillage conducted on rubber estates and, in many instances, the lie of the land will not permit of this as the steep slopes are liable to surface erosion. As far as rubber is concerned it is questionable whether deep tillage will repay the cost of the operation, but if it is recommended, then it should be done in conjunction with green manuring.

ON badly drained, flat land, where the root system is superficial, deep tillage is disastrous as the roots are severely damaged. Shallow tillage towards the end of the wet season is beneficial as it assists in retaining soil moisture over the dry period.

THE coconut palm responds well to tillage and several coconut estates are now using motor tractors. This palm is grown almost entirely on the plains and to a small extent on undulating land where tractors can be used.

In fruit orchards the turning over of the soil, once a year, is necessary to obtain good yields; but, unfortunately, this is not done except by a few progressive growers.

Annual crops are very much neglected as regards cultivation; it is not possible to obtain good results unless the soil is brought to a fine tilth and maintained in a high state of fertility.

Chinese vegetable gardeners are fully aware of this; but, when annual crops are grown on a field scale, sufficient cultivation is not, as a rule, given. The small holder devotes little or no care to soil treatment except in the case of rice and vegetables.

The method of cultivation generally adhered to, on the larger estates, is clean weeding; the reason for advocating this system is the necessity of detecting the presence of "lalang" (*Imperata arundinacea*), a noxious weed which is more easily detected if the land is clean weeded. Lalang is a disastrous weed to any crop, and it is essential that proper supervision be given in order that it may not become established.

European estates are practically free from lalang, but—unfortunately—the same cannot be said of small holdings. Clean weeding on flat and on gently undulating land is perfectly sound, but on no account should it be carried out on hill land which is subject to soil erosion.

Soil Conservation. The hills and undulating land of the Peninsula are subject to considerable surface wash when the land has been cleared of jungle, shrub, or grass, and the importance of preventing this is now fully recognised.

The surface layer is rich in humus and available plant food; consequently, denudation is responsible for a reduction in fertility and of deterioration of the texture of the soil. It is doubtful whether green manuring and the application of artificial manures will ever compensate for this loss of surface soil by wash; and, in any case, the expenditure involved in attempting to restore this fertility is heavy. There are several methods of conserving surface soil, the most common and effective being the growing of a cover crop. Other methods are strip weeding, circle weeding, catch pits, terracing, bunding, and the planting of strong growing grass in contour. On undulating land a leguminous cover is recommended. In the case of very steep slopes, catch pits are not very effective and it is frequently impossible to establish cover crops. The most satisfactory method is strip weeding in contour, or circle weeding around the trees. Terracing is an ideal system but it is difficult to construct a terrace in contour in planted areas without doing considerable damage to a number of the trees.

It is frequently found that the surface of a soil is so hard that the rain water flows over it and only a small amount of moisture is absorbed. Catch pits are useful in such cases, as a considerable proportion of the water is retained by the pits and gradually passes through the soil.

Drainage. On the plains, the water table is, as a general rule, near the surface; but there is considerable variation in different soils and in various districts. Soils with a high water table require to be thoroughly well drained before any attempt is made at planting. In the case of the rubber tree it is essential to have the land well

drained in order that a good tap root may be formed. In water logged land the roots of the rubber tree are superficial and it frequently happens that, during wind storms, many of the trees are uprooted, especially if "thinning out" has been done. In badly drained areas the trees are poor yielders of latex, are not well grown, and are liable to become diseased. Most other crops require equally good drainage.

LAND subject to tidal influence is not recommended unless the water can be kept off the land by flood gates. Flat land, well drained, has a more constant and regulated supply of moisture than is found on undulating or hilly land; this is of importance as it assists a crop to withstand a dry spell. The conditions of flat coast land are generally such as necessitate adequate drainage to permit of good returns being obtained.

Cover Crops. Cover crops are frequently associated with green manures; and, although the former will also perform the objects of the latter, green manuring is done principally for incorporating organic matter in the soil so as to improve its physical condition. One of the most important factors which commends the growing of covers, at least on hilly and undulating ground, is the prevention of surface wash. A suitable permanent cover should provide heavy shade on the surface in order to retard the growth of weeds. The cost of weeding is high when lalang appears in cover crop areas; for this reason, a most careful selection of the plant should be made in order that it will thrive on the land and thus provide the maximum shade with the minimum risk of lalang becoming established. In young clearings no

difficulty is experienced in growing a cover, provided the top soil is even moderately rich; but in badly washed areas it is a different proposition and it is necessary to prepare the spot thoroughly for the reception of the seed. This may be done by constructing a low furrow, in contour, and applying a handful of well rotted cow manure at the positions where the seeds are to be sown in the furrow.

THE first four years in the history of a rubber or coconut estate is the most suitable time for improving the land by means of incorporating green manure in the soil, and it is unfortunate that more advantage is not taken of this period to improve the mechanical condition of the soil.

GIVEN good land, there is probably no cover more satisfactory than *Centrosema Plumieri*. One of its special advantages is that the labourers can pass over the cover without the slightest difficulty or inconvenience; it can be recommended also as a green manure. When it is established, in a young clearing, it will continue to thrive under comparatively dense shade. Owing to the low cover which it provides on the land it is a successful means of preventing soil wash, but it should be clearly understood that it is most difficult to get it to grow on eroded surfaces; for this reason, it should be planted before such damage has been done, as unquestionably a good top soil is essential for its proper growth.

Vigna oligosperma is now finding much favour as a cover plant; it has much to recommend it, but unfortunately it thrives well only on certain classes of soil.

Review of Crops. The three chief agricultural crops in the Peninsula are rubber, coconuts, and rice.

COFFEE, once a crop of some importance, now occupies comparatively a small area as a secondary crop to rubber. Coffee requires to be grown on the richest soils of the country before it is likely to prove a financial success; it is not recommended to grow it as a sole crop, but inter-planted with some other form of cultivation.

THE best and steadiest crops of Liberian coffee have been grown on land of a peaty nature and low country. Robusta coffee thrives best on a loose clay-loam soil.

SUGAR was at one time cultivated in the Peninsula, principally in Province Wellesley and Lower Perak, but it is now only grown by the small holder for the local market. A number of improved varieties of sugar are under trial by the Department of Agriculture. It is unlikely, however, that sugar will receive much attention as a planting proposition for the present, owing to shortage of labour.

A great deal of interest is now being taken in the production of vegetable oils and new sources of supply. The African Oil Palm (*Elaeis Guineensis*) has attracted much attention lately and there is every reason to believe that the oil palm will thrive in most soils in this country which are capable of holding a fair proportion of moisture, but rich moist soil would probably give the best return. It would be expected that this crop would generally be suited to soils of the coconut type and this is probably correct, but remarkably fine specimens have been grown on gently undulating land. There are large areas in the Peninsula suitable for the cultivation of the oil palm and, judging by the number of applications received by the Department of Agriculture for information on the subject, it is likely that

this industry will develope. One estate in Selangor has obtained exceedingly good results, both as regards yield and quality. The Department of Agriculture is in a position to supply seed in fairly large quantities and is in touch with other sources of supply.

THE industry is an attractive one from several stand points. There is a very wide market for the oil which is required in vast quantity, and the price in normal times is fairly steady. In Malaya, it would be possible to work a property on up-to-date lines, but how this will compare with the native industry in Africa is difficult to say.

IN addition to coconuts and the African Oil Palm there are other oils which may be grown with success. There is an import of ground nut oil into the Peninsula equal in value to approximately $2,000,000 a year. Several estates have taken up the cultivation of groundnuts, and special mention might be made of one property in Perak where satisfactory profits have been made. There is a ready sale for the oil and, provided the crop is grown under suitable soil conditions, its cultivation can be recommended. Gingelly is another oil with possibilities.

THE cultivation of Tea has, from time to time, been the subject of some interest but it has never been planted except on a small scale. There is little doubt that tea may be grown with success in Malaya; and, provided suitable labour is available and a market can be found for the produce, it should prove a sound undertaking.

THE Malay Peninsula was at one time the principal spice growing country in the East Indies and large quantities of pepper, cloves, and nutmegs were

exported annually. This industry has dwindled down until it is now of little importance. The spices that are produced command good prices. The experimental cultivation of these crops on a commercial scale is being undertaken by the Department of Agriculture.

TAPIOCA, which was formerly grown on a considerable scale, is still cultivated, though to a less extent, in Negri Sembilan, Pahang, and Johore.

THE cultivation of fibres has created a considerable amount of interest recently, many enquiries having been received by the Department of Agriculture regarding them. Those of chief interest are Roselle, Manila, Sisal, and Mauritius. Roselle Fibre is being grown on one or two estates on a commercial scale, and seed has been distributed by the Department of Agriculture to nearly a hundred applicants. There is a good local demand for the ropes which are made from Roselle and a certain amount of the fibre is being exported. Roselle is a four months' crop and it is recommended to grow it in rotation with groundnuts. It thrives in a variety of soils and seems well suited to Malayan conditions. Arghan Fibre has created much interest, but there is comparatively little information on the subject.

Kapok (Kabu-Kabu). This is grown by Malays generally throughout the country, but in very small quantities. If the facts concerning the market were better known, and collection organised, the cultivation of this crop might be extended.

THE Department is giving serious consideration to these aspects of the problem. One or two capitalists are interested in the growing of Kapok on a commercial scale.

Tobacco. The Department of Agriculture has carried out experiments on tobacco cultivation, and the conclusion has been reached that the production of this crop is possible on average good soil.

THE class of tobacco recommended is that suitable for the manufacture of cigars which are popular among the Asiatics; it will be wiser to fill this demand rather than to encourage the cultivation and curing of tobacco for the European market.

SAMPLES of tobacco leaf grown at the Government Plantation, Kuala Kangsar, Perak, were favourably reported on by local manufacturers.

THERE is a considerable quantity of tobacco leaf imported from Sumatra and Burma and manufactured into cigars locally. It must be remembered that locally grown tobacco is protected by Government, as it is not liable to the import duty on tobacco.

Tuba Root (Derris Elliptica). A good deal of interest is being taken in the cultivation of Tuba Root. Chinese gardeners appreciate its value, but grow it on a small scale only, mainly for the purpose of providing an insecticide for use in their vegetable gardens. The cultivation of this crop, however, is being considered by the larger planter and one or two estates are now growing Tuba on a fairly large scale. The Ministry of Agriculture and Fisheries, London, report that there is, as yet, no trustworthy information concerning the relative toxic contents of the different species of *Derris* or of the varieties of the species *Derris Elliptica*, since botanic specimens have not been

obtainable. Every endeavour is to be made by the Department of Agriculture to obtain suitable botanical specimens for purposes of identification. The Ministry further state that it is at present too early to answer definitely as to the probable demand for the product; but there is no doubt that *Derris* has valuable insecticidal properties and that it will take its place among the older insecticides, if it is handled in a sound manner from the commercial point of view.

Native Agriculture. Agriculture, other than the cultivation of rubber, coconuts and padi, as carried on in this country, consists of "mixed farming." It is almost entirely in the hands of the Chinese and Malays. Near all large centres of population are found Chinese market gardeners who supply the local markets with vegetables, and in some cases send their produce to the larger towns in the Peninsula. Such cultivation is conducted under Chinese methods, which carry with them obvious objections. The Chinese have also been the pioneers in numerous other crops; of which tapioca, pineapples and, formerly, gambier and pepper are the more important. Tapioca is less cultivated than was the case a few years back, owing to the fact that the land has been "worked out" and, in most cases, has since been planted with rubber. Pineapple canning—a Chinese industry in Singapore—has diminished, for the canners find difficulty in obtaining sufficient pineapples to keep their factories working. Cultivators, on the other hand, are less inclined to plant pineapples, as they impoverish the soil. There has, however, been a revival recently in this cultivation.

Sarawak Bean (Dolichos Hosei), as a Cover-Crop under Young Rubber.

THE efforts of the Chinese to establish fruit industries is worthy of note. There are now a few good fruit orchards, owned by Chinese, principally in Malacca and Penang, from which markets are regularly supplied.

THE Malays lack the organizing power of the Chinese, and also their industry. The competition for life has never been keen with them, as with the Chinese in China, and this is reflected in their agricultural systems. Generally speaking, one may state that Malay agriculture lacks effort, and their systems are devised without respect to the amount of labour involved. This is surprising in an easy-going race, but the reason probably is that their wants have been so simple that the work involved in supplying necessities is comparatively small. It must be remembered that, until recent years, the Malay obtained the majority of his necessities from the jungle, and that his mentality has, as yet, hardly grasped the new order of life. As time goes on, Malay life recedes from the jungle, and with the diminishing knowledge of jungle produce which follows, he has to rely more on cultivated plants.

THE gradual transition from this old order to the new was rudely interrupted by the introduction of rubber into Malaya. In this crop the Malay saw that he might earn sufficient to supply his wants without much effort. The consequence has been that agricultural enterprise amongst Malays has been practically killed—he has lost his old cunning without acquiring new experiences in agriculture.

NEW systems have to be introduced to change this order of things. Comparatively little can be done with old Malays of set habits of life, but much is

possible with the younger generation. It is for this reason that the Department of Agriculture has advocated a system of agricultural education (really rural economy) for Vernacular schools.

To deal with present day "Native Agriculture" as it applies in particular to Malays, nothing can be done without encouragement; one can call to mind many industries that are suitable for Malay adoption, but only so far as they are encouraged in the correct way. For the introduction of an agricultural industry amongst natives there are two essential conditions—firstly, instruction in cultivation and marketing; and secondly, financial aid. The matter of instruction is in the hands of the Department of Agriculture, and that of organization of small industries must be dealt with by the recently created Government Co-operative Department. In the publications of these two bodies will be found the suggestions for the improvement of native agriculture.

THE following agricultural industries suitable for Malays and other Asiatic owners of small holdings may be mentioned.

Padi. This cultivation, under existing conditions, is more suitable for small holders than for planters on a large scale. The main difficulties have been water control and cost of labour. Padi yields, outside the Krian area, are generally poor, and until the Malay is supplied with better types of seed, and can be more sure of a regular water supply, there is not likely to be any increase of area planted under this crop.

Fruits. Apart from a few imported fruits, and the supplies obtained from Chinese-owned orchards, the local market supplies of fruit

are obtained from Malay "Kampongs." There is obvious scope for larger areas than those which exist, for the local demand exceeds the supply. With the introduction of larger areas must come better cultivation, if small orchards are to be carried on at a profit. The quality of most of the Malayan fruits is poor, and it is notorious that many of these fruits are but jungle trees. The Government have in hand schemes for the supply of good fruit stock to Malays; but, owing to slow maturity of fruit trees, the progress of such work must be gradual.

AMONG the multitude of minor crops grown by natives, on which advancement is possible, might be mentioned tuba (used as an insecticide), coconuts, coffee, chillies, areca nuts, spices, tobacco, roselle fibre and kapok. No account, however brief, of potential native agricultural industries would be complete without mention of live stock.

THE Malay homestead has been made familiar to us by its straying hens, but the production of hens and eggs as an industry is practically untouched. The Malay and, to some extent, the Chinese fowl is neglected. It is underfed, badly housed, and poor in quality. Consequently disease amongst poultry is rife and the native obtains but a poor return from this source. The few poultry farms that exist have proved that the rearing of good poultry in this country is possible and profitable. There is, therefore, an opening for the raising of poultry in this country under careful control.

Rubber.

Rubber.

THE programme of the British Cotton Industry Research Association lays down as two possible lines of advance:—

(1) To attack problems directly by methods based on past experience without seeking to investigate the fundamental nature of the process.

(2) To try to understand the chemical and physical changes produced during manufacture and so to establish gradually a broad roadway along which future advances may be made.

IF for " manufacture " be substituted " growth " an excellent definition of the aim of the best form of scientific research for the improvement of any crop is obtained. Unfortunately this fundamental method is almost painfully slow and laborious, and the first method is bound to be employed at the birth and during the youth of any industry.

Research and Rubber Growing. As it happens, the Para rubber tree is a plant concerning which it is decidedly dangerous to argue from analogy, and even now nothing is known of the processes involved in the formation of latex. Realising therefore that the present plantation practice is the result of dearly-bought experience in the laboratory and in the field, the methods by which modern scientific research may be expected

to assist plantation companies to pay the largest dividends over the longest possible period are, in one form or another, the object of all agricultural work. Apart from economic factors, such as effect of increased production on selling price, the principal methods must be those for the improvement of yield per unit area (due regard being paid to the cost of collection), at the same time preserving the trees in a perfect state of health over as long a period as possible.

In the case of new areas, considerable expectations have been aroused by the benefits which it is hoped to derive from the planting of selected stock. From some points of view attention would appear to have been unduly concentrated on what is after all an experiment, affecting the relatively small area likely to be planted in the immediate future. It is necessary to point out that expectations of this nature are based on *a priori* arguments and not on actual results, and it remains to be proved that the variability admittedly existing in rubber is fixed, and that high yield can be transmitted from parent to offspring.

It is not suggested that selected stock should not be planted, but that planters should realise that their hopes may not be fulfilled. It would certainly be inexpedient at the present time to plant widely (say 50 trees per acre) in the hope that all the trees, because selected, will be highly yielders.

The real need for research of the second type has been recognised by the F.M.S. Government since 1904 when the Department of Agriculture was formed. Steady increases, both of material and personnel, have taken place since that date.

Rubber Estate, shewing Tapping by Single Cut on a Quarter.

LEAVING aside strictly agricultural methods, it is permissible to doubt whether perfection has been attained in agricultural economics and organisation on the majority of estates; whether, for example, attention to the harvesting powers of workers would not be quite as important as attention to the yielding powers of trees. A similar point is the economic size of plantations; it would seem at least possible that more economical working might be attained by amalgamations of smaller properties.

THE working out of these latter problems, however, would appear to be outside the scope of an Agricultural Department.

Selection of Hevea. Although much has been said and written on this subject, in the absence of experimental proof of the success of the methods which have been suggested and adopted from time to time, it still presents a vague aspect. Thus, the problem of Selection of Hevea is still new and relatively unexplored territory and sorely needs the application of all our knowledge of genetics and horticulture in order to produce high yielding races of rubber trees. "Hevea" is probably the most recent plant brought under cultivation and as such has not yet been affected by the selection which man applies, consciously or unconsciously, to all useful plants. The general method of thinning out, by selection based on yield, will slowly but surely tend to improve the yielding capacity of our trees; though, being perennial plants, capable of living to a fair age, no appreciable effect is likely to be detected within two or even three generations of man. It is still open to doubt whether seeds of the best types of Hevea were imported into the East in the first place, but it cannot be disputed

that the scope for selection amongst the trees on our plantations is very wide. This latter fact is amply disclosed by a study of the accumulated mass of data regarding the variation of our populations of trees. Whatever method of plant improvement is applied to Hevea, it involves in the first place a choice of parent trees, which necessitates a systematic study of the variation between individual trees on a plantation. During the past seven years a considerable amount of investigation has been carried out in this connection in all Eastern rubber producing countries.

WHITBY, Cramer, and several others have published interesting and conclusive articles proving variation in Hevea in almost all its parts; leaves, seeds, bark, branches, root systems, and in quality and quantity of rubber etc.; but we are concerned chiefly with dry rubber production.

IT remains to be proved by experiment that the variation is due to inherent differences, and not to accidental differences of environment, both present and past.

THE Botanical Division of the Department of Agriculture has figures extending over two years, which show that the variation in latex production per alternate-daily tapping, from a population of approximately 500 twenty-eight year old trees, ranges from practically nothing up to 15 ounces or from 0 to 45 lbs. of dry rubber per tree per annum. Moreover, of this population, not less than 11 trees yield over 28 lbs. dry rubber per annum, with alternate day tapping on a V on half the tree, and in every case the cut was situated, during the entire tapping period, more than one foot above the base

of the tree. The magnitude of the variation in dry rubber production is thus very apparent, and it is clear that if pure races of these heavy yielding trees can be produced, then acreage productions on our estates will be vastly increased. The crux of the situation lies in the problem of isolating and propagating pure races of these heavy yielding trees. This problem must be considered as distinct from that of the breeding of trees resistant to diseases or possessing other distinct characteristics.

Two courses are available to the experimentalist:—

Seed selection.
Vegetative propagation.

Seed Selection.

(i) Mass selection.
(ii) Pedigree selection.

It has been found that large heavy seeds of Hevea germinate more rapidly and produce stronger seedlings than those derived from small and light seed, because they carry more food for the young plants and give them a better start in life. Therefore a rough grading of seed into light and heavy groups, with consequent use of the latter only, will produce healthier nurseries than can be obtained from unsorted seed, and thus ensure healthy stock for planting. This method is very superficial and does not take into account the inherent quality of each seed; nevertheless, in mixed populations, it is likely to have a good effect and is one of the few practices which every planter can adopt. Present methods of thinning out trees by selection based on the health and yields of individual trees is really a form of mass selection, though its effects can only be seen in the progeny derived from seed obtained from

estates thinned in this manner, and the results depend on the intensity and thoroughness of the selective thinning. It would be advisable for each large estate to mark its best area for seed production and to adopt a very strict programme of thinning on an area say of one hundred acres for this purpose. In a block of this nature the intensity of the selection of parent trees could be increased from without inwards in such a way that the middle twenty acres would contain only sound, well developed trees of pronounced yielding ability. The seed for the nurseries for supplying new clearings could then be taken from the innermost five acre block. Such seed, resulting from cross pollination between high yielding trees, can reasonably be expected to produce trees of better yielding capacity than the average progeny derived from seed which has not been selected in any way.

At the same time, it must be understood that the progeny from seed selected in this manner is likely to contain a proportion of poor yielding trees because the constitution of the parent trees is unknown; but on well-managed estates this proportion would soon be reduced considerably by ordinary selective thinning operations. Thus, though plantations of better yielders than the average are likely to result from this method of seed selection, the method can never give rise to a uniform highly productive plantation, because it is based on the chance combinations of hereditary characters in previous generations of cross-fertilised trees; it is a useful method, however, that can easily be put into practice.

Pedigree seed selection is by far the best means of improving our plantations permanently, but can only be attempted by trained Botanists, preferably

in Government employ in order to ensure the continuity of work which must spread over more than a dozen years. In order to obtain a high yielding, healthy strain of Hevea it is necessary to isolate a single strain, possessing the required characters, which will breed true to type. Through cross fertilisation in several generations, the present plantation rubber tree is of very complex nature and to isolate such a strain requires a large amount of systematic work, especially since at least three characteristics are involved, namely yield, quality, and disease resistance. Work of this nature has been initiated in Java, though little is known as to its progress to date.

Vegetative Propagation. Methods of propagating vegetatively good yielding parent trees may be divided into two groups; those providing for their own root system, and those in which one tree is grafted on to another. It is probable that the root system is as important to latex production as are the parts above ground. Methods of developing root systems include marcotting and cuttings. The former has been carried out successfully in Java but it is laborious and difficult, and requires horticultural experience.

CUTTINGS carry with them the characteristic root system of the parent tree as far as is known, and if the roots develop well this method of propagation is to be preferred to all others. Unfortunately, this method of propagating selected parents has not, so far, been sufficiently successful to warrant its adoption on estates, but experiments are still in operation. Methods whereby a high yielding, disease-resistant tree is grafted upon another root system are numerous. One of the simplest is budding, which

has already been carried out successfully on many plantations, although the question, whether the yielding ability of the parent tree from which the bud is taken will be unaltered by the new root system of the stock on to which it is grafted, is still problematical and awaits proof.

ALL methods of selection involve careful choice of parent trees and these can only be chosen after definite data and recorded observations have been taken over not less than a complete annual cycle, though an extension to several cycles would give proportionally more reliable figures. The chief factors which should be considered in selecting parent trees are (i) age, (ii) disease resistance, (iii) yield, (iv) robust growth, (v) good bark development, (vi) quality of latex, (vii) situation, (viii) history; though much has been done already in the way of selecting parents, there is still a wide field for research in connection with the study of methods of propagating them and of maintaining pure races of good yielding trees.

Budding of Hevea. The operation of budding Hevea is comparatively simple provided certain precautions are taken. As far as the actual practice of budding is concerned the work is now on an established basis and employed on a number of estates that are planting rubber. As to whether these areas, when in tapping, will give the yields that are anticipated remains uncertain.

THE trees that have been selected as the heaviest yielders on any particular plantation will provide the material for future planting. It is necessary to raise nurseries of robust seedlings as stocks for budding from the selected trees. The seedlings are

ready for budding when from six to twelve months old; older stumps that have already been planted out in the field are not recommended as stocks. Budding should not be performed during the wintering period or during wet weather.

A sharp knife and a supply of waxed binding cloth are required. Ordinary unbleached cotton cloth is suitable and is readily procurable. For waxing, the following ingredients are recommended:—

50 per cent. Petroleum Jelly (Paraffinum Molle Flav).

50 per cent. White Paraffin Wax (melting point 120°/130° F.).

THESE substances are melted together in a kerosine tin over a fire and, after thorough mixing, the mixture is ready for waxing the cloth and is removed from the fire. A convenient size for the cloth is 16 inches wide by 10 yards long. The cloth is immersed in the warm liquid wax and subsequently hung over a frame in a cool shed to dry. After cutting into strips 16 inches long by 1 inch broad, the cloth is ready for use.

MATURE bark only should be used as "bud-wood" and it must peel readily from the branches of the mother tree. The branches should be removed from the trees early in the morning and be cut into short lengths; they are then stored in kerosine tins and covered with damp sacking to prevent evaporation. A rectangular tongue of bark, 2-3 inches long by one third the circumference of the stem, is lifted at the base of the stump, and a bud, attached to a piece of bark of approximately the same size, from the selected tree, is inserted beneath. Buds

are readily distinguishable upon close examination and are situated immediately above a leaf-scar. It is not necessary for the bud-patch to fit the excised area on the stock exactly, as this space serves as an outlet for the latex which exudes from the patch. On cutting the bud-patch from the branch, a portion of wood is frequently removed also; this must be taken out with the point of the knife. The bud-patch after insertion is covered by the tongue of bark on the stock and then bound up with a strip of the waxed cloth which, when rubbed over gently with the hands, becomes softened and adheres to the stem. To prevent the latex from the stock from forming a film over the exposed cambium and thus preventing the proper union of the stock and the bud-patch, it is necessary to outline a number of the incisions a short time before the bud is actually removed and inserted beneath the tongue of bark of the stock.

After two weeks from the time of budding, the binding is removed; the tongue of bark is cut away and the bud-patch examined. Failures may have another bud inserted on the opposite side of the stock and be treated as before.

The successful stocks are left for a week, when they are cut back to within a foot of the living bud. Any lateral shoots that appear must be removed. The majority of the buds will sprout within a month, but 25 per cent. may take as long as six months to grow. The stocks are ready for removal to the field when the sprouting bud is from one to three inches long. After the young trees are firmly established the upper portion of the stock should be sawn off to within one inch of the growing bud. A skilled coolie

Bud-grafting Hevea Seedlings.

Budded Stump, Four Months after Budding.

should be able to bud about 200 stocks a day, with a proportion of success varying from 75 per cent. to 90 per cent.

IT is possible by marcottage of the young tree when one year old to propagate it actually on its own roots; the stock serving as a temporary feeder only.

FURTHER information on the vegetative propagation of selected stock of Hevea is contained in the Agricultural Bulletin, F.M.S., Vol. IX, Nos. 2 and 3.

THERE have now been published a limited number of results of tapping bud-grafts in Java and Sumatra (where the operation was first carried out). These results do not show any marked superiority of budded material over seedlings of similar age, and one Dutch worker has recently stated in a lecture that bud-grafting may be of use only as a means of multiplying material for selection purposes, and not for planting up estates in the ordinary way.

THIS conclusion is possibly as unduly pessimistic on the one side as the confident expectations of enormous yields were over optimistic on the other. The only safe view of the process at the present stage would appear to be that taken from the first by the Officers of the Department of Agriculture, that bud-grafting is an experiment, a necessary, perhaps a vital, experiment but———an experiment.

The Slump. The effect of the world-wide depression made itself first felt in the rubber market in October, 1920, with a fall of price to 52 cents per lb. in Singapore. This fall continued steadily till June, 1921, when the price was 25 cents per lb., after which there was a slight rise to 37 cents

at the close of the year, while the situation was not bettered for the last 9 months of 1922. The cause of the trouble was obvious—over-production relative to the purchasing power of an improverished world; but the equally obvious remedy, restriction of output, proved impossible of attainment by private action. There were many reasons for this, but the primary one was lack of reserve funds which necessitated the highest possible production to cut overhead charges to the lowest point per lb., and to enable Companies to maintain a hand-to-mouth existence.

At first little was done, those interested trusting either that the market would soon recover, and consumption overtake production, or that "survival of the fittest" would operate and the financially or agriculturally weaker properties go out, leaving larger profits for the survivors in the future. It was however soon realised that the same hardiness which makes para rubber so safe an investment *agriculturally in Malaya*, precluded the success of such a policy. Once established, it is almost impossible to kill or seriously injure rubber by neglect, and abandoned rubber can be cleared and brought back into tapping as soon as the price rises to remunerative levels. When it was fully realised that the slump was bound to be prolonged, a strong demand arose for restriction of output and many schemes of voluntary restriction were put forward. None however won sufficient adherents to produce the desired effects, and in November, 1922, a Government scheme of restriction was introduced in Malaya and Ceylon. This scheme permits the export of a fixed proportion of "standard production," varying with the price ruling for the previous

quarter, starting with 60 per cent. of standard when the London price is 1/3*d.* or under. Any rubber above the permitted amount from the F.M.S. exported is subject to a heavy tax. The immediate result of restriction was to raise the price of rubber from –/9 to 1/4 per lb.

Modern Agricultural Practice on Rubber Plantations. The remarkable adaptability of Hevea to widely varying conditions of soil and situation in Malaya and other Eastern tropical countries has, in the past, led to neglect of many agricultural operations, such as tillage, manuring and soil conservation, which are matters of routine in most other cultivations. In many cases this neglect has been justified by results, in others damage has resulted.

THE only work which was early realised to be essential was the drainage of low-lying, flooded coastal lands, but with increasing certainty of the permanence of plantations more attention is being directed to soil problems.

IT is proposed to consider briefly various methods of treatment of the soil, which are considered necessary in certain circumstances; and also problems which require consideration in regard to the plant itself.

Tillage. Any extensive and deep cultivation of the soil is impracticable after the trees are more than about 18 months old, and is in practice only carried out as an operation incidental to the removal of "lallang" when planting up such land. Shallow cultivation suffices for the propagation of jungle soil. In a few cases deep changkolling

(hoeing) or disc ploughing is resorted to and beneficial results have been claimed, but no controlled experiments are reported in Malaya, while recent work in Sumatra extending over three years shows no positive results following cultivation in the case of rubber of seven years of age. It seems unlikely that cultivation of soil will ever become general, or that its adoption will be justified.

Weeding. Clean weeding has long been generally adopted; in addition to freeing the trees from competition, supervision and movement are rendered easier and the light, incidental cultivation is of value by breaking up the hard surface cake or glaze which is readily formed on some soils, and through which rain penetrates with difficulty.

ON flat land there is much in favour of clean weeding, but on hilly land it is thoroughly bad and has resulted in considerable damage by soil wash. Realisation of this fact, together with the present need for economy, has directed increased attention to the use of cover crops.

Cover Crops. The advantages of cover crops are: reduction of working costs, by obviating weeding; and conservation of the soil. The disadvantages are the difficulties of eradication, supervision, movement, and in some cases of early identification of root diseases. *Centrosema Plumieri* is at present the most popular and useful cover for soil in good condition, but cannot be established on poor or badly washed soils. Giant Mimosa (*Mimosa Invisa*) will grow on comparatively poor and badly washed soils. It is necessary to confine this cover to strips between the rows of trees on account of the formidable spines on its stem. On undulating

and hilly land, the cultivation of suitable cover crops, particularly leguminous plants, such as *Centrosema Plumieri*, is undoubtedly preferable to grass and weeds for the conservation of the soil, and is more easily eradicated if necessary.

Green Manuring. Green manuring, i.e. the cultivation and digging in of green cover crops, is generally unnecessary, but may be beneficial before planting up lalang-covered slopes, on which the soil is frequently friable and a poor water retainer.

Manuring. Manuring has hitherto scarcely been practised; and, except on worked-out tapioca, gambier, or pineapple lands, Hevea has done remarkably well without the application of manures or artificial fertilisers. No experiments are available showing the effect of manuring on yield; and, taking into consideration the almost universal response of yield to thinning-out met with in Malaya, it seems improbable that good results are likely to accrue generally. The collection of latex involves the removal of negligible quantities of essential plant foods from the soil (e.g. a crop of 500 lbs. of dry rubber removes less than 2 lbs. of phosphoric acid P_2O_5), and there seems no strong likelihood that manuring will have to be resorted to generally for a long period, except in cases where, owing to the previous history of the area, the soil has become exhausted, or on areas on which rubber should not have been planted on account of original poverty or poor character of the soil.

In some cases it has been possible to correlate poor yields with the condition of the sub-soil; in such cases, any application of fertilisers would be entirely useless and uneconomical.

THE application of large quantities of bulky organic manure, such as cattle manure, would almost certainly be of value on some soils, which, owing to their previous history and cultivation over a period of many years prior to the cultivation of rubber, are lacking in organic matter and nitrogen; but, unfortunately, such manure is available only to a small extent in Malaya. Good results, however, are said to have been produced by applying nitrates during the wintering season and field experiments on these lines are required in Malaya.

Liming. The soils of Malaya are, as a whole, acid—some strongly so—but there is no evidence that acidity, as such, is injurious to rubber, although the resultant inferior soil texture may be. For this reason, improvement of mechanical condition by the addition of quantities of lime, small in comparison with the "lime requirement" (i.e. the amount required to neutralise the acid present) is frequently found to be beneficial. It would often be decidedly dangerous to apply the full amount of lime indicated by routine analysis.

Conservation of Soil. The prevention of soil wash on undulating and hilly land is to-day one of the most insistent problems confronting rubber growers. Wherever possible on such land cover crops should be established; and, in addition or as an alternative, if the slopes are at all steep, silt pits, terraces or bunds should be constructed.

SILT pits are trenches, usually about 2 feet deep and 2 feet 6 inches wide and 6 to 8 feet long, so situated that all but the heaviest storm water with the suspended washed soil is caught and absorbed. The capacity of the silt pits should be sufficient to

retain the heaviest rainfall during any period. A somewhat common error is to place the pits too near the foot of the hill, thus allowing a considerable movement of soil from top to bottom.

TERRACES and bunds are probably better adapted to extremely steep slopes and should be laid down with a due consideration of contours.

IN terracing, the establishment on the slopes of the terraces of a suitable cover crop or of weeds and grass other than lalang, should be carried out. A method of conserving soil which has been practised on estates in Sumatra and on at least one estate in Malaya is that of bunding.

THE bunds are constructed by digging contour pits; the soil from these is used in the construction of a series of bunds, the site and frequency of which are determined by the slope of the land. After the main bunds are constructed, careful watch has to be kept, after heavy rainfall, in order to deal with any particular points, such as the heads of the ravines, which require special treatment. These methods, applied to undulating and hilly land, are of value not only in the conservation of the surface soil, but also in the retention of the rainfall *in situ*, an important factor in rubber cultivation.

IT is important, however, that such methods should be applied if possible at an early stage in the planting up of an estate and not after much of the surface soil has already been removed.

IT is important to realise that wash removes the entire top soil and not merely certain constituents; consequently the damage cannot be entirely repaired by manuring.

In addition to the operations described above for the conservation and improvement of soils, others which are connected with the trees and their yields, such as density of planting and thinning out, have to be considered.

Density of Plantation. On land which has not been completely cleared of jungle timber and stumps, 120—140 trees per acre should be planted in order to allow for losses by root diseases. Where clean clearing has been adopted, and in the case of lalang land free from timber and stumps, the stand may be reduced to 100 per acre. It has recently been suggested that when budded stock is used, considerably wider planting may be adopted. This is, however, considered to be a distinctly risky proceeding in the present stage of ignorance of variation among such stock.

Thinning Out. Disease and accidents may be expected to reduce the stand of trees on uncleared land at the end of the fourth year to 100 per acre; following this will come the removal of obvious wasters (undersized bark-bound trees). This should give sufficient space for the next two years; at the end of this period, a certain number of consistently poor yielders will have been identified and removed, the stand thus being reduced to about 85 trees per acre by the end of the 6th year. Thereafter—if not earlier—disease should be the chief factor in thinning out and every precaution should be taken lest healthy trees which happened to be of moderate development and yield are removed, while diseased trees of better temporary yield and appearance are left, to die later, when every loss is serious. The ideal would seem to be 50 trees per

acre in the eighth, thirteenth to fifteenth year, after which accidents (lightning, wind, etc.) and disease may be expected to do all the thinning required.

On clean cleared properties there is practical immunity from root diseases, but even on such areas tree to tree examinations are advisable with stands of 65 or less.

Much discussion is taking place at the moment on drastic and early thinning out by selection, the argument being that a small percentage (say 30) of trees yield a large percentage (70) of the total crop. No records have been taken over a sufficient period to give certainty of the constancy of yield on the part of these high yielders; on the contrary, it is fairly general experience in Malaya that exceptionally high yielders are to be regarded with suspicion, either as being already attacked by fungi or white ants or as being susceptible to Brown Bast. In any case, the response in yield to such drastic thinning would not be sufficiently rapid to compensate for a loss of 30 per cent. of the crop for a considerable period—while only a small decrease in harvesting cost (itself a very insignificant proportion of the whole) could be expected.

Tapping Systems. There has been decided improvement in tapping systems in that more conservative tapping methods are coming into general use. Single cuts on one third and one quarter of the circumference tapped daily, and the single V on one half the circumference tapped on alternate days are now the favourite systems, superimposed and half spiral cuts being relatively rare.

ALTERNATE day tapping is gaining adherents both on account of economy and reduced liability of trees so tapped to Brown Bast.

AFTER the first year of tapping, the alternate-day V cut may be expected to give 75 per cent. of the yield obtained from a cut on one-third daily. In the first year, the comparison is much less favourable to alternate tapping; and, where a quick return is of importance, the trees might be opened up and tapped for twelve months on a third, changing over to alternate-day tapping at the end of this period.

Conclusion. To sum up, the general trend of thought is now to regard plantations as valuable permanent properties and to treat them accordingly.

WHEN dealing with a slow-growing permanent crop, rash experiments are to be deprecated; and, above all, health of culture should be the main consideration. Phenomenally high yields, lasting for short periods only, would be of little use.

UNFORTUNATELY our knowledge of the physiology of the rubber tree and the relationship of the latex to the general metabolism of the tree is still small.

AT the same time, attention to problems connected with the breeding and selection of improved strains of trees in respect of yield and other desirable characteristics are not being neglected. It is desirable to emphasize, however, that work of this nature must be necessarily slow in the case of a plant such as the rubber tree.

Manufacture and Factory Methods. Consideration of the plantation industry as a whole over the past decade leads to the conclusion that there has been no intrinsic change in the method of preparation of raw rubber over the whole of that period. It is, however, obvious that the present marks a transition stage and the very near future will see alterations in many directions which may be fundamental in their effects. It has been recognised for many years that progress in this industry demands close co-operation between the scientist and the planter, but, owing to the unfortunate condition imposed by the European war and its subsequent economic disturbance, the question of existence in many cases diverted all attention from the future to the present. Those conditions are rapidly passing and the spirit of progress and development is becoming paramount again.

It must be acknowledged also that the period from which the industry is emerging has led to many alterations in manufacture of raw rubber which, although not radical, are of great importance. The problem of variability in plantation rubber which was at one time a distinct drawback to the use of this rubber compared with para rubber, in the opinion of many manufacturers, has now been almost entirely overcome; and it is safe to say that, if the middle man could be eliminated and the producer and consumer brought into closer touch the problem would be entirely overcome. The groundwork which has already been covered by the chemists particularly concerned with investigations into methods of preparation of raw rubber has been extensive, and it has been demonstrated that the vulcanizing properties of plantation rubber can be influenced to

such an extent by scientifically established methods of handling and treatment of the latex and subsequent treatment of the derived coagulum, that the advantages to the manufacturer of the vulcanized material are highly important. Recent publications on the work by Stevens, Whitby and by officers of the Department of Agriculture have added materially to the knowledge of the constituents of Hevea latex and the effect which those constituents have collectively and separately on the ultimate properties of raw rubber and its behaviour during and after vulcanization.

FURTHER, the extensive and increasing use of organic vulcanization accelerating agents, more especially in America, has given an entirely new aspect to many problems of the rubber industry. In any consideration of possible future changes in methods of preparation or even in improvements in details in the manufacture of the present types of plantation rubber, due regard must be paid to manufacturers' requirements. In this connection it is desirable, therefore, to direct attention to other types of variability met with in the factory at the present time.

COMPLAINTS have been made by manufacturers in respect of two other types of variability of the raw material. These consist of a lack of uniformity in the case of "breaking down" on the hot mixing rolls and in the properties of solutions prepared from the raw rubber.

NO investigations have yet been made to ascertain the cause of these types of variability, which are probably connected either with the state of polymerisation of the caoutchouc in the raw rubber, or

with differences in the amounts of the so-called "impurities" or non-caoutchouc constituents, which are invariably present in the commercial product.

It is fitting to draw attention in this connection to the need which exists for the collaboration of the scientific workers in the tropics with those immediately attached to the consumers. All investigation work is useful but it is of vital importance to the plantation rubber industry and eventually to the entire British rubber industry to reap the earliest fruits of scientific investigation by co-operative work in which both producer and consumer can participate.

The price of raw rubber depends on the laws of supply and demand, and consequently any new method for the production of raw rubber, even though it produces a fundamental improvement in the intrinsic quality of the rubber for vulcanization, cannot become an economic proposition for the producer until a demand by the consumer has been established. The latter is, for the most part, absolutely unconcerned as to the development of new processes on the plantation or new types of raw rubber benefitting the planter, but strives rather to check any changes in the properties of a raw material which he has learnt to know in one form, and to handle which he has adapted his machinery. Thus a state of affairs has been created which will only be altered by the closest scientific and economic co-operation of planter and rubber manufacturer.

The Americans have already taken an important lead in this respect. The Hopkinson process for the preparation of desiccated latex or "L.S." (latex sprayed) rubber, depended, for its establishment on an industrial scale, on the consumption for vulcani-

zation in New York of a special type of whole rubber produced in Sumatra; the consuming Company and the producing Company being under the control of one parent organisation. The same organisation has now commenced operations in Selangor, and by its activities bids fair to prove to the industry as a whole many advantages in preparation etc., which this "latex sprayed" rubber possesses over standard 1st latex crepe and sheet.

THE undertakings which the same organisation has also entered into for shipping latex direct to the U.S.A., in connection with their industrial applications of Hevea latex direct for impregnating fibres with rubber, indicate the successful establishment of another very important technical use for this commodity.

IN a much smaller degree but along similar lines a British Company of manufacturers is developing the application of what may be regarded as latex vulcanization, by the adoption, on a rubber estate in Malacca, of the process invented by Dr. Schidrowitz for producing vulcanized rubber direct from latex.

COMBINATIONS of the ordinary hot vulcanization process with raw rubber production on the estate, although successful in one or two instances, cannot be regarded at present as particularly significant.

Appearance and Quality. Unfortunately, at the present time and for some time past, the principal factor which has any influence on the market value of the raw product is its appearance irrespective of the intrinsic quality.

WHILE a good appearance undoubtedly indicates care and supervision in preparation, it does not necessarily follow that appearance is correlated with the

real quality of the raw material, or that certain so-called defects are in any way indicative of inferior quality. For example, the defect known by the brokers as " rust " on smoked sheet is certainly not connected with any inferior quality in the raw material, while the treatment of lower-grade rubber such as lump, cup washings and tree scrap with solutions of sodium bisulphite and sulphuric acid in order to obtain a rubber of paler and more even colour undoubtedly lowers the quality, although such rubber obtains a better market price on account of its appearance.

FURTHER, much pale-coloured native sheet, probably prepared by the use of alum, is converted into blanket crepe in Singapore and fetches a higher price than the darker native sheet which is coagulated with acetic acid and which, on conversion into blanket crepe, has a darker colour. In this case intrinsic quality is certainly not correlated with the appearance. The only point which concerns the individual producer at the present time in connection with the preparation of the raw rubber, is the appearance of the rubber and its superficial valuation by the broker. For some time past, nearly all samples received for investigation have been sent on account of such defects in appearance as bubbles, " rust," streakiness or dullness in crepe, yellow colour of pale crepe, " spot " disease and a few others.

CONSIDERABLE information is now available in connection with the causes of, and remedy for, all these defects. A good superintendent of the estate factory, who is capable of applying advice given in written instructions or in the literature already published, should be capable of dealing with these problems.

IT is still unfortunately a fact, however, that the same problems are continually being raised with requests for advice, which appears to indicate that much of the time which has been devoted by scientists to the elimination of the superficial defects might have been spent to better advantage in other directions.

Coagulation. With the exception of native sheet, and possibly in the case of one or two large estates, all latex is coagulated with acetic acid, nor does it appear probable that any other coagulant is likely to be substituted.

RECENTLY the coagulation of Hevea latex has been made the subject of some further investigations by the Plant Physiologist of the Department of Agriculture and the published results have led to several important modifications of previously established views as to the deleterious effects of certain chemicals as coagulants.

THE chief improvement which has taken place during recent years on large estates is the coagulation of latex in bulk in the preparation of both sheet and crepe rubber, which has resulted in much greater uniformity in the raw material. No special recommendations are necessary at the present time in this connection.

MANUFACTURE of smoked sheet, due to the coagulation of latex of constant concentration in bulk in large divided tanks, has without doubt been considerable. The ideal type of tank, particularly in respect of materials used in construction, has yet to be found and the preparation of sheet in deep

tanks is attended with certain defects, particularly bubbles which affect its market price, far more than in the case of sheet coagulated by the older method in separate shallow, enamelled pans.

TANK coagulation has also necessitated the general use of the anti-coagulant and anti-ferment Sodium Sulphite, the chief effect of which is to reduce bubble formation, since the bubbles are produced by fermentation. Bubble formation is greater in tank than in pan coagulation on account of the fact that the coagulation of latex in deep tanks is partially anaerobic, under which conditions bubbles, due to the formation of gas from the decomposition of the carbohydrates in the latex, are produced.

GREAT care must therefore be taken that the tanks do not become " sour," and they should be washed periodically with a dilute solution of formalin, and the dividing partitions treated similarly or exposed occasionally to the sun.

CEMENT tanks, lined with glass, and with glass or aluminium partitions, are now on the market and would appear to be the most suitable type, preferable to the wooden tanks lined with glazed tiles, with wooden partitions, now commonly in use.

THE important points, in connection with the preparation of smoked sheet, to which attention should be directed are, elimination of " rust " and ventilation of the smoke house. The elimination of " rust " must be effected, on account of the broker's prejudices, although it does not affect the real quality of the rubber. " Rust " is due to the exudation of serum products from the interior of the sheet, which evaporate on the surface and usually form a thin

film which sometimes gives the rubber a wrinkled glossy appearance, especially in the depressions on a "diamond" marked sheet. When the sheet is stretched, the film is broken and appears as a brown rusty deposit. According to some Dutch scientists the film is caused by the bacterial decomposition of the serum products which exude and evaporate on the surface.

Manufacture of Pale Crepe. The manufacture of pale crepe by the use of sodium bisulphite to prevent the normal or natural darkening of the rubber, which is otherwise caused by the action of the oxidising enzyme on certain substances almost invariably present in Hevea latex, calls for no remarks.

THE detail connected with the preparation of this type of raw rubber has been so thoroughly mastered in most well run plantation factories that the product can be guaranteed to a very sharp standard of uniformity and appearance. That the consuming manufacturer of vulcanized goods is not materially benefitted by this elaborate care on the part of the producer seems to be particularly deplorable at a time when the British rubber world as a whole, and the planting community in particular, is so severely handicapped in all efforts towards the re-establishment of improved industrial conditions.

Manufacture of Lower Grades. With the present ratio between production and consumption of rubber and the low market price of rubber, the only lower grade rubber which appears to be worth preparing is that composed of the lump, washings and skimmings and picked tree-scrap, which can be mixed and converted into one grade.

A lighter coloured product can be prepared by soaking the fresh material, as soon as possible after collection, in a bath of sodium bisulphite and acetic acid, followed by a similar soaking of the crepe immediately after machining. This will improve the colour and market value, but not quality.

Packing of Rubber. In spite of recommendations and the invention of other suitable methods of packing, the greater part of the rubber in Malaya is still exported in wooden cases; and no precautions, such as lining the boxes, are taken to avoid contamination of the rubber with dust and splinters from the cases. For local transport to Singapore, however, collapsible canvas cases are employed by some estates and found to be satisfactory and economical.

Two recent inventions consist of cases constructed of a good quality lower grade crepe, or of the dried leaves of the "mengkuang." The market objection to such packing appears to be that the rubber in the lower packages, when in the hold of a ship, becomes consolidated to a solid block owing to the weight of the packages above. Apart from this, such packing material would appear to be very satisfactory.

It is, however, surprising that no extensive attempt has been made generally to line the inside of the ordinary wooden cases with a good lower-grade crepe or even to place a number of the sheets in the box in such a manner that a rubber lining composed of single sheets is formed, which would protect the whole of the remaining rubber packed in the box. However, the producer can probably scarcely be blamed, since, even if he took this trouble, he would not necessarily obtain a better price for his product.

Future Possibilities of Manufacture. It is not possible to forecast any radical changes in the types of "first latex" rubber which may be marketed generally in the immediate or more distant future. The value of "slab" rubber, on account of its specially rapid vulcanising qualities combined with its general superiority as compared with the sheet and crepe, is possibly discounted to a great extent by the remarkable increase and extended use of numerous organic vulcanization accelerators now on the market.

It has, however, been stated by competent authorities that this increased use of accelerators, and particularly the exceedingly powerful types now being evolved, is not altogether without disadvantages to the manufacturer; in consequence of which the production of naturally fast vulcanizing uniform rubber would be well received in the manufacturing industry. Supporting this there is a knowledge of large contracts by a certain progressive Company which were maintained throughout 1923 for a guaranteed type of rubber which vulcanised in an ordinary 9:1 rubber-sulphur mix at 4 times the rate of 1st latex standard crepe and gave a superior vulcanised product. The consumers paid a higher price for the commodity than the ruling rates for standard crepe and the vending Company's production costs were lower than they would have been if their product had been in the ordinary form.

In addition to this it has now been proved that, by careful collaboration of the engineer and the chemist, and by the utilisation of existant plant only, a fast vulcanising, improved type of raw rubber can be produced in crepe form which also possesses the superficial qualities of standard 1st

latex crepe for at least 2/3 the factory costs of standard crepe. What further improvements could be effected in return for capital outlay on plant alteration it is only possible to estimate.

WHEN it is realised that the present most modern development of latex sprayed rubber requires the erection of expensive and patented plant for operation on an industrial scale and then yields a product which does not appear to possess the vulcanising properties of this matured crepe rubber, the prediction of future developments is fraught with uncertainty. Rubber which has been produced by a process which permits of maturation does undoubtedly possess enhanced vulcanizing properties; it remains to be seen whether the general manufacturing consumer is willing to pay for the improvement and whether the producer is prepared to consider the production of the raw rubber as involving factory problems which demand the attention of highly efficient chemical and engineering control with less conservative ideas than formerly if the plantations are to benefit thereby.

WHATEVER method of preparation may be adopted in the future, one fact appears certain, viz., that the fuel problem in connection with the manufacture of smoked sheet will sooner or later become critical. For the present, all the wood being used for this purpose is derived from old jungle stumps or timber on the estate which it is desirable to clear, or from the rubber wood derived from thinning out, but this will not be the case in the future. In the collection of figures obtained on behalf of the Forest Department it has been estimated that approximately 220,000 tons of wood were consumed in rubber factories during 1919. These figures are based on

the consumption of one ton of wood for every 185 lbs. of rubber. The consumption of wood may therefore be estimated at rather more than twice the output of rubber.

IT would appear advisable, therefore, to direct serious attention to this problem and to state that, in the not distant future, some other method of preparation of the raw product will have to be considered, which will eliminate or considerably reduce the large amount of fuel consumed in the smoking. The shortage of wood fuel, apart from its actual cost, may have an important influence on the method of preparation of raw rubber in the future.

Statistics. Rubber was first commercially planted in Malaya about 1895; since then, though checked by the slump, expansion has been steady and rapid.

FIGURES for the last few years show:—

	Acres of Rubber Planted.		Rubber Exported from Malaya.**	
Year.	F.M.S.	S.S. & Unfed. M.S.	Tons.	Value ($)
1920*	—	—	182,059.21	36,074,278
1921	1,234,951	Approx. 1,000,000	169,429.06	12,898,345
1922	1,234,951	„ 1,000,000	248,131.12	18,685,828

* No reliable figures previous to census of 1921.

** Includes re-exports.

THE F.M.S. acreage is made up as follows:—

Estates over 200 acres	696,041 acres.
.....100 and under 200 ac.	68,959 „
..... 25.....100 ac.	64,296 „
.....under 25 ac.	405,655 „
	1,234,951 acres.

THE proportion of small holdings to large Estates in the Straits and Unfederated Malay States is certainly higher than in the F.M.S.

Labour. Figures of labour on estates employing more than 100 labourers may be of interest. A very high proportion of the total are employed on rubber estates.

	Indians.	Javanese.	Chinese.	Others.	Total.
1920	186,876	8,918	40,866	5,838	262,498
1921	133,313	7,997	31,803	4,784	177,897
1922	150,336	6,020	32,260	6,448	195,564

THE large drop in 1921 is another aspect of the slump.

Cereals.

Cereals.

AS agriculture is tending to take a progressively more important position in the industrial life of Malaya, more attention must be paid to the fundamental requirements—food, shelter, clothing—of our agriculturists and the labouring classes.

THESE fundamental necessities, usually obscured in importance by the vast superstructure of conveniences, luxuries and the ordered security of modern civilization, only assume their true values whenever humanity is overwhelmed by a terrible calamity such as the Great War or the more recent earthquake in Japan.

CEREALS form the staple diet of all the toiling millions of the world's workers and their importance as the most valuable of economic crops has been recognised from earliest times.

WE read of their cultivation more than 4,000 years ago, and their significance in the rise and fall of Empires right down to modern times has always been forced upon us. Neither public works nor industrial pursuits of any kind can be carried on without ample supplies of the "staff of life" for the labouring masses, and the price of cereal food is a basal factor in every possible undertaking.

DURING the years 1917 and 1918 the problem of local food supplies greatly perplexed the Government in Malaya because the country was dependent largely on imported cereals, which became alarmingly scarce on account of restricted shipping and because of the increased European demand for rice, so that the sources of supply were unable to cope with the enormous demands. Hence it became necessary to

increase the local production of food, and various measures were adopted to render land the more readily available to agriculturists for cereal and other food crops. These measures, combined with the urgency of the food situation, resulted in comparatively large areas being cultivated temporarily with food stuffs.

WHILE these efforts were useful in increasing local production they fell far short of anticipations because of lack of knowledge regarding the special requirements of each particular crop and shortage of rain.

Rice. Rice is the chief cereal crop in Malaya; indeed, the only cereal of real economic importance. It is the staple diet of 99% of our population and yet the country only produces five-eights of our consumption. Furthermore, only 16% of the population is engaged in rice production. This is an undesirable state of affairs, as will be readily acknowledged by all who experienced the rice shortage which was so keenly felt a few years ago. The Government is fully cognisant of the situation and is endeavouring to further the local rice industry in every possible way. Much is being done in a quiet way by District Officers who aim at getting all suitable land in their districts planted up with rice each season, and assist in repairing water courses, dams, etc. The Irrigation Department strives to find irrigable areas and to establish water control to render such areas independent of rainfall as far as possible. The Agricultural Department aims at the production and distribution of good strains of seed and improved methods of dealing with cultural and other matters connected with the crop.

Malayan Fruits.

It is not generally known that the average area planted with rice in Malaya amounts to 669,262 acres annually, distributed as shown in the following table:—

Province or State.	Area in acres.	Area under rice.	% of total area.	Population 1921.	Area under rice per head.
Kedah ..	2,334,720	174,000	7.4	3,332,603	.51 acre.
Perlis ..	292,000	31,000	15.3	146,064	.77 "
Trengganu ..	3,840,000	10,800	.28	187,762	.07 "
Kelantan ..	3,756,800	175,050	4.66	320,585	.53 "
Johore ..	4,800,000	13,200	.27	80,424	.05 "
Singapore ..	145,000	Nil.	Nil.	85,941	Nil.
Malacca Town ..	3,240	Nil.	Nil.	599,055	Nil.
" Country ..	460,400	27,622	5.9	39,075	.22 "
Dindings ..	117,120	720	.6	123,069	.06 "
Prov. Wellesley ..	179,460	33,500	18.33	130,341	.26 "
Penang Town ..	6,080	Nil.	Nil.	11,850	Nil.
" Country ..	63,750	6,030	8.6	122,851	.15 "
Perak (including Krian)	5,040,000	119,505	2.3	30,671	.2 "
Krian	204,400	55,000	27.	425,912	.64 "
Selangor (K.L. Town)	11,000	Nil.	Nil.	282,234	Nil.
" Country ..	2,037,000	18,410	.9	309,300	.06 "
Negri Sembilan ..	1,632,000	30,400	1.9	153,765	.16 "
Pahang	9,152,000	30,025	.3	40,087	.2 "
Total ..	33,870,570	669,262	1.98	338,558	.204 acre.

THE above table shows that the area of land per head of population under rice is only about one-fifth of an acre, whereas roughly half an acre is required to support one adult for a year. Thus, the only self-supporting States are Kedah, Kelantan and Perlis, chiefly because Malays are predominant in these States.

THE area under rice varies slightly from season to season, the main cause of variation being the incidence of rainfall.

Irrigation. Water supply is the chief factor in rice cultivation, and irrigation on a small scale is a common practice, the Malays displaying remarkable aptitude in diverting small streams so as to get the maximum utility from them. Temporary weirs formed of logs, bamboos, matted sticks and earth are frequently constructed to deviate part of the water of rivers into distribution channels for irrigating fairly large areas. In many places the cultivation is dependent on the annual flooding of rivers. In other places various contrivances (water wheels etc.) have to be erected to lift water from lower levels. In some areas adjustable dams have been constructed and elsewhere fixed bunds serve to conserve the rainfall. Regular controlled irrigation is the ideal, but this condition only exists in a few areas of which Krian, comprising 56,000 acres, is by far the largest. Hill rice is absolutely dependent on regular rainfall during the growing period.

Soils. The best rice soils are the rich, heavy, clay loams which are found most abundantly in the coastal regions and in the valleys between the hills.

SANDY and peaty soils must be rigidly avoided, though the latter type can be utilised provided that the peat is only a few inches deep and rests on a good clay foundation, and that the area is drainable. Sandy soils are useless for padi cultivation unless they contain a large quantity of humus and are well irrigated; but at the best, only poor crops can be expected.

Cultivation. There are two forms of cultivation (a) wet, (b) dry.

MORE than 90% of the rice grown in Malaya is grown under wet cultivation methods, since wet padi is very much more productive than padi grown under dry conditions.

(a) Wet Rice Cultivation. Generally speaking, the more tillage the land receives the better. The fallow grasses and weeds are usually cut down as the first operation. Then the land is either ploughed or dug over and the weeds are incorporated with the soil. Following this, water is run on to the land, which is then puddled by buffaloes or by rolling, raked free of weeds, and finally brought to a consistent muddy condition for planting seedlings. The seed is usually

sown in dry nurseries; that is, in soil which is not subject to inundation, though under certain conditions wet nurseries with two or three transplantations are employed. Planting is practically always done in 4—6 inches of water. The water helps the seedlings to stand erect until new roots have been formed, and is retained on the land until 6—8 weeks before harvest.

In very soft areas ploughing is dispensed with, the only cultivation given being a thorough clearing away of weeds and grasses. In many places a forked iron rod is used to assist in planting seedlings, to ensure that their roots are pushed well into the soil, and at the same time to obviate excessive stooping. Otherwise all planting is done by hand. The usual planting distance is 14 by 14 inches.

(b) Dry Rice Cultivation. There are, broadly speaking, two forms of dry cultivation. In the more common method the land is simply cleared of bush frequently burned over, and no attempt is made to remove large stumps or to till the land. Seed is sown, 4 or 5 seeds per hole, in holes about 2 inches deep spaced some 14 inches apart, the holes being made by a blunt ended pole. In the other form of dry cultivation the land is thoroughly ploughed and crossploughed; then raked, after which operation the seed is broadcasted at the rate of 6—8 gallons per acre. The crop is entirely dependent on rainfall for its moisture.

Malayan Vegetables.

Harvesting. Harvesting is all done by hand labour, the crop being cut either by sickle or by using a peculiar crescent shaped knife with which each ear is cut separately.

Threshing. This depends on the method of harvesting. If a sickle has been used the padi is tied in bundles and beaten against a ladder placed in a large open tub. If the crop has been cut ear by ear, then threshing is generally done by treading the heaps of ears with the feet. Very occasionally, the heaps of ears are beaten with sticks, but this is a slower method.

Winnowing. Winnowing is most frequently done by using the natural breeze which blows fairly steadily during the day in normal harvest weather. Otherwise, simple wooden hand-winnowing machines are utilised; or, where these are not in vogue, the Malay women use shallow circular baskets and depend on their own dexterity to separate the grain from the chaff and straw by gravitation.

Crops. Seasonal variation naturally has a very marked effect on the crop from year to year, and the yields differ enormously from district to district in the same season. The following table shows the average annual crops for the last 10 years:—

State or Province.	Average area under rice.	Average yield per annum in gantangs.	Average yield per acre in gantangs. Wet.	Dry.	Average yield per head of population in gantangs.
Kedah	174,000	44,001,000	253	165	130
Perlis	31,000	5,340,000	192	162	133
Trengganu	10,800	2,000,000	200	151	130
Kelantan	175,050	32,436,050	193	162	105
Johore	13,200	1,424,000	160	76	5
Singapore	—	—	—	—	—
Malacca Town ..	—	—	—	—	—
„ Country ..	27,622	7,712,000	246	—	63
Dindings	720	84,000	135	102	7
Prov. Wellesley ..	33,500	9,310,000	282	151	72
Penang Town ..	—	—	—	—	—
„ Country ..	6,030	2,261,730	370	—	58
Perak (including Krian)	119,505	21,173,500	241	121	35
Krian District ..	55,000	13,869,000	267	90	161
Selangor (K. L. Town)	—	—	—	—	—
„ Country ..	18,410	1,424,000	145	57	4.5
Negri Sembilan ..	30,400	4,602,000	160	187	25
Pahang	30,025	4,223,000	163	104	29
Total Malaya	669,262	135,991,280	203	110	41

FROM the above table it can be seen that the average yield derived from wet padi is 203 " gantangs " per acre, that is, just over 1,000 lbs. of unhusked rice. It may also be seen that the yields derived from wet padi are approximately double those obtained from dry padi cultivation.

Milling. Chinese enterprise copes with the milling in areas which produce a surplus above consumption. There are 10 large power mills in the country, but there is rarely enough padi to keep them all fully running. Several large rubber estates have installed small power mills and purchase padi directly from the producers for milling, to supply their own labour with rice. The cultivators use 2 types of simple mills for milling for their own daily needs. One type consists in pounding the padi in a mortar either by hand, foot or water power, and in the other type the padi is hulled between revolving milling surfaces, the surfaces being made by cementing together a number of laths of hard wood in a matrix of hardened clay.

By-Products. Milling by-products are relatively unimportant. The bran and polishings are used as cattle, pig and poultry food, and the husks are burned as fuel for the power mills.

Pests. Pests, other than rats, are rarely serious unless the soil is poor or moisture is insufficient. Rats do an immense amount of damage annually and it is most difficult to induce the cultivators to adopt measures to exterminate these vermin. Poison and traps are effective if only the rayats would employ them properly. Birds are very destructive in small isolated padi areas but the cultivators take more trouble to counteract their depredations than they do those of rats. The chief

insect pests are stem-borers (*Schoenobius sp.* and *Diatraea sp.*), sucking bugs (*Leptocorisa sp., Podops sp., Nephotettix sp.*), mole crickets (*Gryllotalpa sp.*), and grass-hoppers. Eel-worms sometimes do a fair amount of damage in sandy or peaty soils. Stored grain is liable to suffer badly from various weevils, if no precautions are taken.

Manures. Manures are little used because of their high costs, though where natural manures like guano are easily obtained they are readily applied. Nitrogenous and phosphatic mixtures appear to be the best manures for rice under ordinary conditions and applications of burnt crushed bones are common.

Selection. The Department of Agriculture has succeeded in isolating at Titi Serong, the main Rice Experiment Station, several heavy yielding strains capable of giving increased yields up to 25% above yields derived from unselected seed. The selected strains are being distributed and cultivators recognise their value so that natural redistribution is taking place in many areas. The importance of increasing the local production of rice may be emphasized by the statement that Malaya imports annually $34,000,000 worth of foreign grown rice—rice which is not as wholesome as the local product.

Maize. (Zea Mays). Next to rice, maize is our most important cereal. It is never seen planted on large areas, but occurs in countless small garden patches scattered throughout the Peninsula, and it is impossible to collect statistics of areas and yields at the present time. It is a comparatively new crop in Malaya, but there is no reason why it should not gradually assume

Pineapples (Ananas sativus), Interplanted with Young Rubber.

the proportions of a field crop on a large scale, since varieties of it appear to suit all local conditions, though good crops can only be grown on good soil.

Soils. The best soils for maize are the rich, light, sandy loams which are found along the banks of most of our rivers; but any fairly open-textured soil, provided that it is well supplied with organic matter, is capable of producing a good crop. Peaty soil must be avoided and heavy clays are not suitable unless intensive methods of cultivation are employed, which, as a rule, are too costly.

Cultivation. The crop responds readily to cultivation, so that the land should be thoroughly dug over and cleared of all weeds and roots. The seed is usually dibbled into shallow holes 2 inches deep, spaced about 9—12 inches apart in lines, which are marked off at intervals of 3 feet. Generally 3 seeds are dropped in each hole and lightly covered with soil by the foot of the sower. Surface cultivation between the lines is advantageous throughout the growing period. Seed is rarely broadcasted.

Crops. The crop matures in 2½—6 months according to the variety. Yields depend entirely on the richness of the soil, freedom from the ravages of pig, and suitable weather, but an average rate of yield of 600 lbs. per acre may be expected from medium soils. The best soils, like those on the banks of the Perak River, are capable of yielding at the rate of 1,800 lbs. or more per acre. Two or three crops can be grown successively on the same soil with good results, but rotation of crops is highly beneficial. The cobs when ripe must be well dried and stored in closed receptacles, as they suffer badly from weevils.

Uses. The crop is either cut green for sale as a vegetable or permitted to mature. It is usually crushed into meal and eaten as a porridge, sometimes ground into flour to make bread, sometimes boiled whole, like rice, or eaten raw as a light midday meal. The stems and leaves make an excellent fodder. The crop is of considerable economic importance as a garden crop and is likely to become a much more extensive cultivation in the future.

Ragi. (Eleusine Coracana). The third cereal for Malaya is ragi, but after rice and maize none of the cereals are worth much consideration, except as emergency crops under special circumstances. Ragi proved most helpful during the rice shortage in 1917 in supplementing the restricted supplies of rice. Its great advantage is that it can be grown on very poor soils which would be quite unsuitable for rice or maize, and most estates possess small disused patches of land which answer this description.

It grows best on well drained loams and will not tolerate inundation. The soil is thoroughly cultivated and pulverised and the seed may be broadcasted or, better, transplanted from a nursery. The crop occupies the soil for six months and the yields depend largely on weather and soil conditions and the intensity of cultivation, but an average of 800 lbs. per acre is easily obtained, if precautions are taken to scare away birds.

When mature, the heads are gathered and the stalks are left in the soil to be eaten by cattle, or burned or dug out for the next crop. Threshing is done by beating piles of the dried heads with sticks and

the chaff and husks are blown away or separated by the dexterity of the women using shallow baskets. The grain is boiled whole, like rice, or ground into flour for baking.

Millets. Several millets can be grown successfully but are very favoured by rice birds which are extremely detrimental to the crops. These crops are at present of no economic import, since they are less nutritious compared with other cereals and less productive under existing conditions, though, like ragi, they may be useful in times of emergency.

If damage by birds is eliminated, millets can produce crops of anything up to 1,200 lbs. according to the attention given to cultivation.

Sorghum. Sorghum is another crop which growns well in Malaya under efficient cultivation, but which is of no economic importance. It yields about 1,000 lbs. of grain under good cultivation in fertile soil, but is generally entirely consumed by birds.

Job's Tears. (Coix Lacryma—Jobi). This crop is frequently grown by the aboriginal Malays (Sakai) in their hill clearings and is occasionally found on dry loamy land near river beds. There are hard and soft shelled varieties and the crop matures in 3—4 months, though harvesting is very prolonged on account of the unequal ripening of the grain on each stalk. It is dibbled into the soil at 15 inch intervals or, rarely, transplanted. It is of no economic importance and is inferior as a food crop.

Fruit and Vegetables.

Fruit.

ALTHOUGH there are numerous varieties of fruits represented in Malaya, yet their quality, with very few exceptions, leaves much to be desired. Until recently, local fruit trees rarely received the necessary amount of cultivation and careful propagation, and it is to these causes that the present unsatisfactory position is due. The fact that, in spite of this lack of care, native-grown fruit trees frequently bear large crops, points to the conclusion that considerable improvement both of yield and quality is possible if scientific methods of cultivation were the rule rather than the exception.

CONSIDERED as a possible commercial undertaking, it is probable that a well managed orchard, in which good varieties of fruits were grown, would be successful. With the exception of pineapples and limes, no Malayan fruits have received the application of modern methods; but this, and the introduction of improved strains from other sources, are problems that require attention.

THE favourable qualities of selected trees can only, in many instances, be perpetuated by asexual propagation, and it appears possible that many of the fruits suitable for local cultivation may eventually be propagated by means other than seed. There are but few varieties that can be raised from cuttings with any degree of success; layering is little practised, propagation by seed or by marcottage being the usual system employed. The problem

requiring elucidation therefore is the nature of stock most suitable for planting. If seed be used, its source and subsequent treatment are matters of importance. The Department of Agriculture is engaged in raising a large stock of material suitable for planting out, in order to satisfy the constant demand of planters who experience considerable difficulty in obtaining young fruit trees. Work has also been carried out upon the importation of stock, with the result that the Avocado Pear and Brazil Nut are now successfully established in the country.

Owing to the difficulty of consumers in obtaining suitable fruit locally, there is a constant demand for imported fruits, of which oranges, litchis and mangoes are examples, in addition to jams and canned fruits of all descriptions. It is felt that the local supply should, in fact, supplant these imports, but this desideratum will only be attained when growers realise that they should market a first class product, thus obtaining a regular market and a higher price, instead of the low quality consignments which at present find their way to the local markets.

The local fruit grower confines his attention to the more common varieties for which he finds a sale. Durians, Mangosteens, and Bananas are the best of their products, and are found in most districts; Rambutans, Pulasans, and Papaya being grown to a less extent. In Malacca, Penang and Singapore, good Chiku are produced, but inferior qualities are frequently sold in other towns.

The following are the principal fruits for dessert purposes:—Chiku, Coconut, Duku, Mangosteen, Papaya, Pineapple, Plantain, Pomelo, Pulasan, Rambutan and Sugar apple.

FRUITS for stewing and preserving are:—Belimbing, Carambola, Carounda, Guava, Papaya, Pineapple, Pitangi, Roselle and Rumeniya: while fruits for the preparation of cooling drinks are Lime, Orange, Roselle and Soursop. Many of the above are admirably suited for jam making, but the practice of preserving is only undertaken by a few residents.

ORANGES are frequently grown, but the varieties are not generally of good quality, being too acid for dessert purposes and more suitable for cooling drinks. A Singapore resident has had marked success as regards the improvement of the Orange, and has now obtained a type with a good flavour for which there is a ready local market. There are some excellent Pomelo trees, the fruits having a delicious flavour, and very succulent; but on the average, the type grown is poor.

THE best soil for fruit culture is found in the plains and valleys formed from alluvial deposits brought down from the mountains. Undulating land is quite suitable, provided that there is little or no soil wash. Peat land is, as a rule, unsuitable for fruit cultivation. On flat land, good drainage is essential. Where damage is likely to be occasioned by windstorms it is desirable to plant strong-growing trees at right angles to the direction of the prevailing winds.

THE distance of planting is a matter of great importance. In this country, trees are generally planted too close together, and are frequently planted out from the nursery when too young. October and March are the most favourable seasons for planting. Land occupied by fruit trees should be clean-weeded, or a leguminous cover crop planted

over the area; and on no account should "lalang" (*Imperata arundinacea*) be allowed to occupy the ground. If clean weeding is adopted, the land should be tilled once annually; while light or heavy soils can be greatly improved by digging in a green manure during this operation. Mulching fruit trees during the dry seasons is seldom practised, but, by experiment, has been found of great value.

REGARDING the general care of fruit trees, attention should be drawn to the necessity for the control of insect pests and diseases. Pruning is almost unknown amongst natives, and is a point that requires further investigation.

Pineapples (Ananas Sativus). The pineapple is a native of Tropical America, but has been introduced into all tropical countries and is extensively grown in South America, West Indies, Cuba, Hawaiian Islands, Malay Archipelago and Queensland.

IN the Malay Peninsula the pineapple is grown both for dessert and canning purposes; the largest planted areas are to be found in the Island of Singapore, where there are several large canneries engaged in the preserving of the fruit. The local industry is very large, as will be seen from the following figures, which show the exports from Singapore during the past three years.

		Quantities. Cases.	Value. $
Exports,	1919 ..	255,873	3,286,001
„	1920 ..	446,890	7,177,976
„	1921 ..	662,360	6,210,383

THE rise in the value of exports in 1920 was due partly to the revival of trade, immediately after the war, and partly to the fact that supplies of

tin plate, practically unobtainable during the war, were more available. The principal country for export is the United Kingdom, but Canada, British India and the United States of America absorb fairly large stocks.

Cultivation of Pineapples for Canning. The variety most commonly grown for canning is a "Queen" type of pine, which is very similar to the "Red Jamaican Pine" of the West Indies. The fruit is very small, weighing from 3 to 5 lbs. and has an excellent flavour when tinned. The "Mauritius" and the "Smooth Cayenne" or "Kew Pine" are chiefly grown for dessert purposes.

ALTHOUGH the pineapple will grow on most soils, provided they are well-drained, it usually thrives best on the stiff clay types of soil. A rich soil appears to be unsuitable as it tends to develope the size of the fruit at the expense of the flavour. Pines grown on some of the poorest Singapore soils have the best flavour when canned.

Planting. The pines are propagated usually from the suckers which are obtained from the base of the fruit, the suckers being allowed to dry slightly in the sun before planting. They can be propagated also by means of the off-shoots or suckers from among the lower leaves of the plants. A common method of planting is in rows 5 feet apart, the plants being spaced 2½ feet apart in the rows, with a 6 foot path at every 100 feet. About 3,000 suckers are required to plant up an acre.

AFTER planting, the fields require careful weeding, but are not generally manured. Fortunately the pineapple has few insect enemies and is not subject to many diseases.

Yield of Fruit. The pines begin to fruit at from 12 to 18 months, and during the first year of fruiting will produce one fruit per plant; but, with good cultivation, they should produce an average of about two fruits to each plant every year after the first year of fruiting. Under ordinary conditions the average yield of pines is about 4,000 to 5,000 per acre per annum.

THERE are usually two main crops during the year, the first in May and June and the second in November and December, but the crops depend very much on rainfall. When there is a spell of dry weather of long duration the pines do not fruit.
A properly cared-for estate, as cultivated in the Straits Settlements, will produce good fruits for 5 to 6 years, after which the pines gradually become smaller, and it is usually found necessary to remove the old plants and replant strong fresh suckers.

Canning. The pineapple canning or tinning industry is in the hands of Chinese merchants. In the Straits Settlements, the pines are always peeled and cut by hand, as hand labour is found to be more economical. The peeler wears a rubber glove on the left hand as a protection from the juice of the fruit. After peeling, the pines either whole, in slices or in cubes are placed in tins, which are filled either with water or syrup. In the case of whole pines, the cores are removed previously, if required, by a tin tube which is pressed through the centre, but most pines are tinned without coring. The syrup consists of about 3 parts of sugar to 100 parts of water, but is varied with the ripeness of the fruit. After the pine is put into the tin, the tin is soldered up and a number of tins are placed on a wooden rack slung on wires

and plunged into a rectangular tank of water heated by means of steam-coils. The tins are boiled in this tank for ten to fifteen minutes in the case of the smallest tins, and up to an hour for large tins, the biggest tins weighing 5 pounds when full. After removal from the boiling water a puncture is made in the top of the tin with a hammer and punch; in large tins two punctures are made. This is done to allow the steam to escape; the holes are resoldered and the tins plunged again into boiling water for about nine minutes. They are then labelled and packed in boxes for export.

THE forms manufactured for export are (1) whole pines, (2) sliced pines, and (3) chunks or cubes. The most popular size is the 1½ lb. tin, which is shipped in wooden cases containing 4 dozen tins.

Machinery. The greater part of the machinery employed in the canning factories is necessary for the manufacture of tins, and consists of tin plate cutting machines, cover and bottom presses, and rolling machines for making the tins. The tin plate is imported from the United Kingdom and the tins made completely in the canning factories in Singapore.

General. Owing to the main crop maturing in two comparatively short seasons during the year, the working of the factories is very irregular and it is necessary to employ much additional labour during the height of the fruiting seasons. The prices paid for pines are somewhat high at the beginning and end of the seasons, but they are, as a rule, so low during the height of the May/June crop that the grower gets practically no profit.

THERE is usually a small supply of fruit available between the main cropping seasons, and the canner has to rely on this to keep his factory running during these periods. The supplies are usually supplemented by purchasing fruit from outside sources where the fruiting season does not coincide with that in Singapore, and fairly large quantities are shipped to Singapore from Port Swettenham: when it has to be transported such long distances, the fruit is cut just a little under-ripe. Towards the end of 1921 there existed about six canning factories in Singapore, two near Johore Bharu on the mainland, and one in Selangor.

Bananas (Musa Sapientum). The banana or plantain is to be found cultivated throughout the whole of the tropics on account of its highly nutritious fruit. It is undoubtedly the commonest fruit on the local markets, where it is sold chiefly for dessert purposes. A large number of varieties is cultivated, and it is therefore impossible to describe them all in this place.

Cultivation. The banana flourishes best on heavy soils fairly rich in organic matter, and in moist situations, providing the soil is well-drained. The plant is liable to be damaged by heavy winds and should not be planted in exposed situations.

IT is propagated by suckers, which arise from the roots of the parent plant. Suckers for planting should be selected only from vigorous plants. The land selected should be cleared and then carefully holed and lined ready for planting. The holes should be fairly large and filled up with good soil, cattle manure or humus. The average distance of planting is from 10 to 15 feet apart, according to the particular variety to be planted. If planted in dry

weather, a mulch of cut grass should be placed round the suckers to prevent excessive evaporation. Weeds must not be allowed to grow immediately round the plants and the soil should be frequently stirred.

THE banana plant appears to utilise a large proportion of potash from the soil and all parts of the plant are rich in potash. In Queensland the application of potash fertilisers has been effective in increasing yields.

THE first bunch of fruits is produced about a year from the date of planting, but this depends upon the variety grown. The plant will throw out several suckers, forming a clump, but only four or five of these should be allowed to grow. After removing the fruit the stem should be cut down to allow the subsidiary suckers space to expand. With good cultivation these will soon bear fruit and the plant will continue to be productive for from four to six years, during which time it will yield an average of two bunches of fruit per annum.

Banana Flour. A new industry, which has recently been started in the West Indies, is the manufacture of banana flour.

ANY kind of banana or plantain is suitable for the preparation of banana flour, but for economic purposes, the variety which produces the largest weight of fruit (excluding the skin) should be grown, apart from other considerations, such as liability to attack by pests and diseases. In this country the *Pisang Raja* on account of the size of its bunches, size of fruit and high productivity, is recommended as the most economical variety for flour.

THE bunches should be cut when about three-quarters grown, otherwise the fruit will become too ripe and the starch be converted largely into sugar. THE bananas are peeled, sliced thinly with a nickel, bamboo or other knife which does not darken the fruit, and the slices laid on wooden trays in the sun to dry. Under good conditions the drying takes from two to three days. The dried slices are crushed in a corn mill or pounded in a mortar, and sifted through fine muslin.

ON a large commercial scale, artificial drying is resorted to; this is carried out preferably in vacuum driers at a low temperature, or in special chambers or rooms in which the peeled and sliced bananas are placed on trays on endless travelling belts or conveyors, and dried by forcing or drawing hot air through the chambers.

Uses. In this country large quantities of bananas are consumed either as dessert or cooked as food, and very little, if any, fresh fruit is exported.

A large quantity of fresh fruit is consumed in the United Kingdom, where it is estimated that over 9,000,000 bunches are imported annually, principally from the West Indies.

A new and rapidly increasing trade in the West Indies is now being carried on with dessicated bananas, which are used in the manufacture of banana flour, the latter having the peculiar flavour and odour of the fresh fruit.

BANANA meal or flour is highly nutritious and very digestible, and is used largely as a food for invalids and infants.

General. The banana can be produced so cheaply in this country that it should be possible to ship fresh fruit to the Southern and Western States of Australia; and, provided ships on the Singapore—Australian route were fitted with special refrigerating space, there appears to be no reason why a profitable trade should not be developed between the two countries. The fruit can be purchased on the local markets at considerably less than a cent each and, if delivered in good condition, could probably be sold in Australia at a price equivalent to 5 or 6 cents.

THERE is at the present time a small import duty on bananas in Australia, but in spite of this, fairly large quantities of the fresh fruit are now being exported to that country from Java.

Limes (Citrus medica, var. acida). The lime is cultivated to a greater or less extent in all tropical countries for its acid, juicy fruit, which is used principally in the manufacture of cooling drinks. It is grown as a commercial product in the West Indies, and the export of concentrated lime juice and citrate of lime forms the chief industry of the island of Dominica.

FORMERLY, citric acid was obtained from the Sicilian lemon (*Citrus medica, var. lemonum*), but during recent years the lime has to some extent taken its place.

THE lime plant requires careful attention in its cultivation, as if grown under unfavourable conditions it is subject to severe attacks by both insect pests and fungoid diseases, which will affect the yield of fruit to such an extent as to render cultivation on a field scale unremunerative.

Cultivation. A rich loam soil on flat ground is considered the most suitable for the cultivation of limes, although it will thrive on most soils except stiff clays.

THE plant is propagated from seeds or cuttings, but budding and grafting are frequently adopted. The seed is usually sown in carefully prepared nursery beds, which should be 5 feet wide, slightly raised above ground, and shaded. The seeds should be sown in lines 8 or 9 inches apart, with an interval of 2 to 3 inches between the seeds in the lines; sufficient seed should be sown to allow for losses in the field. When the seedlings are four to five inches high they should be transferred to other nursery beds, where they are replanted 6 to 9 inches apart, the tops being nipped off to produce a thick well-branched tree. When the seedlings are about one foot high, they should be planted in the field. The usual distance of planting is from 15 to 20 feet apart according to the nature of the soil; the richer the soil the greater the spacing.

MATURE lime trees are not usually clean-weeded except for a small area round each tree, but the grass between the rows should be cut regularly.

CAREFUL attention must be given to pests and diseases and a sharp watch should be kept for plant parasites, which are very liable to attack the trees. Scale insects are usually the most troublesome pest.

UNDER ordinary conditions the lime tree commences to fruit at from three to three and a half years from the time of planting, and at six to seven years will give an average yield of 1,500 to 2,000 fruits per tree per annum.

ALTHOUGH the plant produces fruit throughout the year, fruiting is usually more pronounced during two periods, following the wet seasons.

IT is estimated that, on well cultivated estates in the West Indies, one acre of limes will yield 24,000 lbs. of fruits, equivalent to 11,550 lbs. of raw juice, or 914 lbs. of citric acid. In addition, 65 lbs. of hand-pressed oil are obtained from the rind of the fruits.

Commercial Products. The products of the lime which are in demand commercially are:—

(1) *Green Limes.*—Consisting of specially selected fresh fruit.

(2) *Pickled Limes.*—Yellow selected limes, steeped in several changes of sea-water and shipped in casks of sea-water to which salt has been added.

(3) *Raw Lime Juice.*—Prepared by expression of the fruits and containing normally 12 to 14 ozs. of citric acid per gallon of juice.

(4) *Concentrated Lime Juice.*—Prepared by evaporating raw juice in either open or vacuum pans.

(5) *Citrate of Lime.*—Prepared by raising the raw juice to boiling point by means of steam coils in large, lead-lined, wooden vats, and neutralising the acid of the hot juice with milk of lime. The citrate of lime thus produced as an insoluble precipitate is allowed to settle and the clear liquor run off. The product is then dried by heating. In the preparation of a high grade product, further details in manufacture must be observed.

(6) *Essential Oils.*—Derived from the rind or peel.

(a) Hand pressed oil is extracted from the rind of the fruit in a special machine before crushing in the factory and (b) distilled lime oil is obtained from the raw juice by a preliminary distillation of the raw juice before evaporation in the preparation of concentrated juice.

Uses of Commercial Products. Fresh and pickled limes are used for the preparation of cooling drinks and for flavouring purposes; raw lime juice is used in the manufacture of lime-juice syrups and cordials. Citric acid, produced from citrate of lime, is used largely in connection with the textile and dyeing industry and in the manufacture of other fine chemicals, while the essential oils are employed in perfumery, as a flavouring for essences and confectionery, and in the preparation of scented soaps.

Citric Acid. Until recently the product of the fruit was exported from the West Indies in the form of raw juice, concentrated juice or citrate of lime, but attention is now being directed to the manufacture of citric acid in estate factories.

CITRIC acid is usually prepared by treating the citrate of lime with sulphuric acid, sufficient acid being added to convert the whole of the calcium citrate or citrate of lime into free citric acid, which remains dissolved, leaving the calcium sulphate formed in the reaction as an insoluble sludge. The solution of citric acid is filtered from the insoluble calcium sulphate sludge in mechanical filters, and the crystals of citric acid are obtained by evaporating the clear solution to a concentration at which the crystals will separate from the solution on cooling. The exact point is usually determined by means of hydrometers.

CAREFUL factory control and some experience are required in the manufacture of concentrated juice, and more especially in the manufacture of calcium citrate or citric acid, scientific chemical advice is necessary or desirable in the first instance, unless the factory superintendent has received preliminary training in connection with the manufacture of these products.

Possibilities in Malaya. One estate in Malaya has already taken up the cultivation of limes on a small commercial scale and it is intended in the first instance to manufacture concentrated lime juice, for which the necessary plant has been obtained. There should be a good Eastern and probably an Australian market for the products, although whether this country can compete with the West Indies in the European and American markets remains to be proved. The chief difficulty at present is the supply of a suitable wood for barrels. In the case of citrate of lime or citric acid, which are solids, this difficulty does not arise, since barrels constructed from suitable local wood could probably be made. Wooden boxes or cases would also be quite satisfactory for the packing of citrate of lime or citric acid for export. In the case of the liquid products, raw lime juice, and concentrated lime juice, the barrels would have to be of better construction and of strong wood to prevent leakage. It is not possible in this place to include full details of the processes of manufacture of the various products, but full information on this subject, including methods, machinery, and cost of plant required, can be obtained on application to the Department of Agriculture.

Vegetables.

THE Malay Peninsula is exceedingly well adapted to the cultivation of tropical vegetables, which can be grown more or less throughout the year. The quantity produced locally, though large, is not sufficient for the requirements of the country, consequently the inhabitants have to rely to some extent on the importation of vegetables from Java and China. There is ample room for extensive development in this form of cultivation, both on the hills and in the low country. Chinese small-holders and "Squatters" are the chief growers, and their plots are well distributed throughout the country; but, even in the neighbourhood of large towns, no well-known market garden is to be found. These Chinese obtain extraordinarily good results; but, unfortunately, their produce is not always grown in strict accordance with sanitary principles and therefore fails to command as large a market among Europeans as it would command, were it grown under better supervision. One is surprised by the immense trouble and care that a Chinaman takes in his garden, and the high state of fertility which is ultimately reached. He has an intimate knowledge of this branch of agriculture and uses it to considerable advantage, but his small capital limits him to production on a small scale, with only the simplest of cultural implements. The Tamil rarely grows more than is sufficient for his own requirements, while the Malay takes little or no part in the production of vegetables. The European

has developed rather more interest in the subject during the past few years, with the result that many are now to a certain extent independent of the market supply. Managers of rubber estates, as a general rule, have opportunities of making and maintaining a vegetable garden, but more advantage might easily be taken of these opportunities. It is unlikely that the European will ever grow sufficient to contribute to the market, but it is not improbable that he will finance the Chinaman to an extent which will enable him to use more modern types of implements and will induce him to grow more of those vegetables for which there is a European demand. The capitalist of the country looks mostly to Rubber and Coconuts as an investment and has probably never considered seriously the possibilities of vegetable culture. Around the large centres there is undoubtedly room for progress in this direction; and, considering the cost of importing vegetables from other countries, it would appear to be a profitable investment.

Tropical vegetables are well represented and of good quality but could without doubt be improved by selection. European vegetables such as potatoes, carrots, beet, etc. are almost entirely imported; they cannot be grown successfully on the low lands but there is ample scope for their cultivation on the hills, where they have been proved to do well. At the Government Gardens, Maxwell's Hill, Taiping, Perak, such vegetables have been grown satisfactorily for years; and, as other hill stations are developed, gardens of a similar nature will undoubtedly be established. In India and Ceylon vegetables are extensively cultivated in the hill-country, and the towns on the plains derive a fair

supply from this source. There seems little reason why Malaya should not do likewise. The demand for potatoes alone is sufficient to warrant the opening up of large areas.

In making a vegetable garden there are many factors which require to be taken into account. The situation should be an open spot, preferably on a slope facing east. A good water supply, conveniently situated, is essential. The type of soil is very important and Chinese market gardeners pay the utmost importance to the selection of land with abundance of humus. Deep loams or alluvial soils, rich in humus and moderately light, are most suitable and require the minimum amount of preparation. Sandy and laterite soils require heavy and repeated applications of organic manure. Clays, on the other hand, are too heavy, cold and damp, and are as unsuitable as barren sandy soils. It is not to be expected, however, that either very light or heavy soils, particularly the latter, will ever attain the same degree of perfection as a naturally well-balanced alluvial soil. One of the principal features in vegetable growing is the maintainance of a high class tilth; tillage makes the soil more porous and permeable to roots, enables vegetable and mineral matter to decompose more rapidly, promotes oxidation and stimulates the activity of the nitrifying bacteria, checks the growth of weeds and reduces evaporation of soil moisture. The depth of cultivation required will depend on the nature of the soil and of the vegetable grown.

Manuring is as important as tillage. Frequent applications of one or more organic manures, such as cattle manure, fish refuse, guano, oil cake, leaf

mould, etc. are required in order to maintain soil fertility. Well rotted cattle manure is the best form of organic manure for vegetable cultivation.

THE judicious planting of successive crops, in rotation, is of considerable importance. A rotation of crops is resorted to in ordinary practice in consequence of the economy of manure and variation of root growth which result from this practice. Certain crops are subject to special diseases, and the eradication of such diseases is often effected by the introduction of other types of crops. Plants of the same order should not follow each other. Deep and shallow rooted crops should, as far as possible, be grown in succession. A leguminous plant should be included in the rotation. The source and storage of seeds must receive careful attention. It is of primary importance in the combating of insect and fungoid attacks to ensure that the plant is maintained in a vigorous condition by good cultivation. When practicable, hand picking of insects should be resorted to; this applies in particular to the numerous species of caterpillars which feed on stems and leaves. Several fungoid diseases do considerable damage and are kept in check preferably by strict plant sanitation. Good cultivation and drainage, judicious manuring, rotation of crops, isolation of infected areas, destruction of diseased plants or tissues, freedom from wounds, artificial watering and careful pruning when necessary, are factors which tend to reduce the possibilities of attack and spread of disease.

THERE are numerous factors which require to be considered in making a selection of vegetables for the garden. In small gardens a selection of edible leaf and stem vegetables should be grown as these

cannot be bought in the markets with any degree of safety. Of root crops, the sweet potato is the most important cultivated here; it is eaten by all nationalities in Malaya, particularly by the Chinese. There are numerous varieties; but, of the two commonly grown in this country, one reaches maturity in about three months from the time of planting, while the other takes six months. The former type is the more popular. An introduced variety, known as New Jersey Red, produces large tubers of excellent flavour. Experiments have shown that the largest crops of sweet potatoes are grown on land that has been ridged. This tuber can be grown on any moderately good friable soil. Propagation is effected generally by cuttings from semi-mature portions of the stem. As a sole crop, the ordinary early maturing variety will produce a yield varying from two to three tons per acre. The cost of growing a crop of "three months" sweet potatoes is approximately twenty-two dollars (Straits) per acre.

ANOTHER important root crop in this country is the Yam which can be grown successfully on comparatively poor land; a sandy loam is preferable, but deep tillage and good cultivation are more important than quality of soil. The greater or "ten months" yam (*Dioscorea alata*) is the species most commonly cultivated in Indo-Malaya. Cultivation is a comparatively simple matter. Propagation is from sets taken from the mature tubers. An average crop is about six to seven tons to the acre, costing from thirty five to forty dollars to produce. This root crop forms an important article of food both for Europeans and natives.

KELADI (*Colocasia antiquorum*) is grown to some extent by the Chinese. In the West Indies it is a well-known crop and is an important tuber vegetable.

THE Jerusalem Artichoke (*Helianthus tuberosus*), Sunroot, is cultivated locally and is a favourite vegetable with Europeans. Artichokes thrive best in moderately light rich soils, but do quite well when grown under less favourable conditions. Mature tubers are used in propagation. The crop takes from four to five months to reach maturity. A fair average yield as a field crop would appear to be about ten tons per acre.

THE Yam Bean (*Pachyrhizus tuberosus*) and Elephant Yam (*Amorphophallus campanulatus*) are worthy of mention as subsidiary root crops.

THERE is quite a variety of beans which can be grown on the plains; special mention might be made of the Lima Bean (*Phaseolus lunatus*) which has recently come into favour as a food crop in this country. The large-seeded varieties make an excellent vegetable either shelled from the green pods or dry. The lima bean will grow in any moderately good soil. Seeds of this bean have been distributed by the Department of Agriculture, F.M.S. & S.S., to many residents in the Peninsula; it is a prolific yielder and its cultivation should be encouraged in this country, where it does so well.

OTHER beans which do well in the low country are the French or Kidney Bean, Egyptian Kidney Bean, Four-angled Bean, Sword or Jack Bean, Cow Pea and the Pigeon Pea.

SOME of the favourite native vegetables which can be grown successfully on the plains are the Gourd, Brinjal, Ceylon-Spinach, Chillies, Chocho, Endive, Ladies Fingers, Loofah, Lotus, Pumpkin, Shallot and Snake Gourd. Lettuce, Tomatoes, Onions, Maize, Parsley and Water-cress all do well in Malaya. Lettuce and Tomatoes are very favourite vegetables; and, as they can be grown so easily throughout the year, it is somewhat surprising to find comparatively few Europeans who cultivate them.

COMPARATIVELY little success is obtained at low elevations with the following vegetables: Asparagus, Beet, Carrot, Cabbage, Celery, Potato, Leak, Parsnip, Radish, Turnip and Vegetable-marrow, but all of these can be grown successfully on the hills.

Oils and Fats.

Oils and Fats.

ONE of the features of modern commerce is the provision of adequate supplies of those raw materials essential to mankind, not the least important of which are oils and fats. There is no need to insist on this; the numerous ways in which oils and fats are consumed in daily life, either directly or indirectly, are so familiar to all that the necessity of being assured of adequate supplies can be taken as vital.

UNDOUBTEDLY the greatest consumption of oils and fats is among the dense populations of the temperate zones, who are unable, by reason of climatic and other conditions, to supply their requirements, while the chief source of oil materials lies in the relatively sparsely populated tropical regions.

MALAYA is no exception to this; the chief oil-bearing plants grow well in this country but, up to the present with the exception of coconuts, little has been done as regards exploiting them. The chief reason for this is that the main interest of the country is centred in the production of plantation rubber; but, with the recent decline in the price of this commodity, there is reason to believe that more attention will be given to extending the cultivation of various oil-bearing plants, especially those which can be grown under similar plantation conditions.

IN this article, therefore, a short survey will be given of those oil-bearing plants which are being cultivated in this country, or with which experi-

ments are at present being carried out; together with brief notes regarding the methods in general use for the extraction of oils and their industrial applications.

Classification.—Before stating how oils and fats derived from vegetable sources are classified, it is perhaps necessary to state that the difference between an oil and a fat depends solely on temperature, for a fat when melted is termed an oil and an oil when solidified becomes a fat. An instance of the manner in which the temperature of a climate affects this nomenclature is seen in the case of coconut oil, which in this country is a liquid and would therefore be regarded as an oil, while in Northern Europe it is a fat.

OILS from vegetable sources are classified as either fixed or essential. By the term fixed is meant an oil which cannot be volatilised without undergoing chemical decomposition, while the opposite applies to essential oils which are sometimes known as volatile oils.

THERE is also a great difference, from a chemical point of view, between the two classes. The fixed oils and fats are mixtures of glycerides of fatty acids; that is to say, chemical compounds formed by the combination of glycerine with fatty acids, and which yield glycerine and soap when treated with caustic alkalis.

ESSENTIAL oils, on the other hand, consist of mixtures of highly complex organic compounds such as, for example, hydrocarbons (compounds of carbon and hydrogen), alcohols, aldehydes, and esters, which do not react with caustic alkalis in the same way as fixed oils.

It is advisable therefore, to describe these two classes separately, since the methods of extraction and the commercial uses are so distinct.

Fixed Oils. *Occurrence and Extraction.*—Fixed oils are found chiefly in the seeds of plants where, together with starch and proteins, they are available as food which would be required by the seed if allowed to germinate. The preparation of the oil therefore consists in an extraction from the seed, and is carried out by one of two methods, either by a mechanical process of submitting the seed to high pressure in a press or by treating the seed with chemical solvents which will dissolve only the oil.

When pressing oil seeds or nuts, the general method at present in use is as follows: the seeds or nuts are cleaned and decorticated if necessary, and the kernels converted into a pulpy meal by being passed between a series of rolls.

If the oil is to be used for edible purposes, the meal is then expressed in the cold, such oil dissolving the smallest amount of extraneous impurities from the seed. By pressing in the cold, only a portion of the oil can be recovered, so the cakes are disintegrated and the meal heated and pressed again. If the material is particularly rich in oil, or if the oil is viscous, this process may have to be repeated and a third expression carried out.

It will be seen that it is only possible with certain seeds, for example castor oil, groundnut and gingelly, to employ the cold pressing method; this would not be possible where the oil is solid at the ordinary temperature, as for example with palm

kernels or copra, or where the oil content of the seed is low, as in the case of cotton seed. In such cases, therefore, after leaving the crushing rolls, the meal is heated and pressed direct.

THE presses employed in modern oil expression practice are of the hydraulic type; they vary in design, the two chief types being the Anglo-American open press, and the closed cage press.

THERE are also machines in use called "expellers" which are designed to combine both the crushing and the preliminary pressing. These machines work on the principle of a screw conveyor, the raw material being fed through a hopper at one end and being forced out at the other through the annular space between the screw and the outer casing.

IN the second process the oil is extracted from the meal by means of hot or cold chemical solvents. The chief solvents in use are carbon bisulphide, benzene, carbon tetrachloride and trichloroethylene. Briefly, the process consists in allowing the hot or cold solvent to percolate through the meal contained in a series of closed vessels, when the solvent will dissolve out the oil. The solution is then transferred to a heated still in which the solvent is distilled off, leaving the oil behind. The solvent can be recovered and used again.

THESE two are not necessarily rival processes but are worked together, sometimes in the same mill. Thus, certain seeds can be crushed cold in order to obtain a high-class edible oil, and then treated by a solvent extraction process to recover the remainder of the oil, since with the latter process it is possible

Germinating Seed Coconuts.

to recover all the oil in the seed, whereas by pressure alone it is rarely possible to obtain more than 90 per cent. of the total oil content.

In general, it may be said that the method of expression is invariably followed if the cake is to be used as a feeding stuff, as the small amount of oil therein forms a valuable constituent. In the case of mouldy or damaged seed material, where the cake could not be used for this purpose, or where the cake cannot be employed on account of some poisonous principle, the solvent extraction process is to be preferred.

Application and Uses.—It would be difficult to enumerate all the uses of oils, but among the chief are the applications which they find in the manufacture of butter substitutes (margarine) and other preparations for edible purposes, soaps and candles, paints and varnishes, linoleum, leather and lubricants. To a certain extent the industrial application of an oil depends on whether it belongs to the drying class of oils. The surfaces of such oils, when exposed to air, film over or solidify; and this property, which is known as drying, is taken into account when selecting an oil for utilisation in the manufacture of paints and varnishes, the film produced forming the protective coating on the material treated. In all these applications, except in the case of soap and candles, the oil must be free from a large excess of fatty acids; otherwise it must undergo a preliminary refining process or be used as soap or candle stock, in which case the presence of free fatty acid makes little difference.

As stated above, the oil cake or meal remaining after extraction forms a valuable bye-product, either as a cattle food or fertiliser. It is more profitable

to use this residue as cattle food and to return it ultimately to the soil in the form of cattle manure. In the case of some seeds, for example, castor oil seed, this is impossible, since the meal or cake contains some poisonous substance, and can therefore only be utilised directly as a fertiliser.

Essential Oils.

Occurrence and Extraction.—Unlike fixed oils, which occur almost entirely in the seed or fruit, essential oils may be found in various parts of the plant; the leaves, roots, flowers and bark; for example, in the case of the rose, the oil is obtained from the flower petals, while in lemon grass the oil is present in the leaf. Nutmegs contain both fixed and essential oils. Frequently, too, more than one essential oil occurs in a plant; thus in the case of the cinnamon tree, the bark, the leaves and the roots all yield different oils.

ESSENTIAL oils occur in plants generally in very small amounts; it is seldom that the yield of oil, calculated on the weight of fresh material, exceeds a few per cent., frequently it is less than one per cent.

THE methods employed for the production of essential oils may be classed as follows:—

(1) Steam distillation of the plant.
(2) Mechanical processes.
(3) Solvent extraction.

WITH regard to the first method, which is by far the most important, the distillation from the plant material is carried out by means of steam, all essential oils being readily volatile in the presence of water vapour.

THE distillation is carried out in a still, connected to a condenser around which cold water circulates. The still is provided with a false bottom, on which the plant material is placed. Steam is passed through the still, thereby volatilising the oil. The mixture of oil and steam is condensed, when the oil—not being miscible with the water—rises to the surface or sinks to the bottom according to its density.

MECHANICAL processes are employed in the case of such oils as lime and lemon, in which the essential oil is present in the rind of the fruit. There are two or three variations of this process, the most common being the so-called " ecueille " process. An ecueille is a saucer-shaped vessel, usually made of tinned copper, fitted with a hollow stem, the inside of the saucer being covered with short spikes. The fruit is placed in the ecueille and, with a rapid circular motion, the oil cells are ruptured, the oil exuding and running down into the hollow stem.

EXTRACTION processes involving solvents are employed principally for extracting the scent from flowers of delicate perfume, which would be impaired were the flowers to be subjected to steam distillation.

TWO kinds of solvents may be employed: volatile, such as alcohol, benzene, ether or chloroform; and non-volatile, such as neutral animal fat.

IN the case of volatile solvents, the extraction consists, as in the case of fixed oils, in allowing the solvent to percolate through the flowers. The solvent is distilled off and the residue utilised for the manufacture of so-called floral essences.

In the case of the non-volatile solvent, the fresh flowers are laid on trays covered with a thin layer of the neutral fat, and replaced until the fat has become saturated. The scented fat is then removed and sold as "pomades," which are employed in the manufacture of perfumes.

Application and Uses.—Essential oils are used principally as perfumes, flavourings for foods and drinks, and in medicine—in the last case either as specific drugs or as flavourings to render a medicine more palatable. It will be readily understood that, except for those of medicinal value, this class of oil is in reality a luxury and not, as in the case of the fixed oil, a necessity.

MAIN OIL-YIELDING CROPS.

It is considered that the two main oil-yielding crops best suited to the conditions prevailing in this country are coconuts and African oil palm. As regards coconuts, this crop is now the second in importance in the country, while the experimental work carried out up to date on the cultivation of the African oil palm indicates clearly that this particular crop is also capable of being developed on a plantation scale to meet the ever-increasing demand for oils and fats.

COCONUTS.

(*Cocos nucifera*).

The coconut is undoubtedly the palm of the greatest economic importance, being found distributed throughout the tropics.

Distribution.—As regards Malaya, there is no doubt that the climate is suited to the growth of coconuts, which thrive well throughout the whole Peninsula,

particularly in the coastal districts. Such land is generally flat, and is usually provided with natural outlets and sufficient fall to allow of thorough drainage. The soil is mostly alluvial, and palms grown under such conditions commence flowering in their third or fourth year. Coconuts are, however, cultivated in the inland districts, but there they take longer to reach the producing stage.

In Malaya, the principal areas in which this crop is to be found are: Penang; Province Wellesley; Krian; the Dindings; the Bagan Datoh district in Lower Perak; along the coast from the Bernam river to Sepang in Selangor; the coastal districts of Pahang, Johore and Kelantan.

Cultivation.—The most suitable soil for coconut cultivation is an alluvial loam, but some of the stiff clays, when properly drained, also produce excellent crops. When the area to be opened up is low-lying, as is common in the coastal districts, rentices are first made through the jungle and the main drains cut immediately, in order to dry the land as much as possible before felling is commenced.

The next operation is to lay down the nursery. Nuts for seed should be gathered from well-matured palms, between fifteen and forty years old, which are known to be good yielders. The nuts should be fully matured before being picked from the tree and allowed to dry for one to two months after they are picked, in order to harden the husk. Nursery beds, about four feet wide, should be carefully prepared with good soil, and slightly raised to permit efficient drainage. A thin layer of sand on the surface of the beds is beneficial as it prevents the ground from becoming too damp and causing

the roots to rot. When the beds are ready, the seed nuts should be partly buried in rows about two feet apart in an oblique position, with the acute end of the nut downwards. The seed beds are shaded for a time, but the shade should be gradually removed and the plant fully exposed before it is ready for planting in the field. The best age at which to remove seedlings from the nursery for transplanting in the field is from five to seven months. If left in the nursery longer, the difficulty of transplanting is greater and the roots are liable to get damaged.

AFTER felling and burning operations are finished, the land is thoroughly cleaned and prepared for planting. The best distance of planting in the field is 30 ft. x 30 ft. square, which gives 48 trees per acre. The area should be carefully lined and holed ready for planting. The holes, which are usually made two feet wide and two feet deep, are filled up with good surface soil and the seedling planted so that the top of the nut, where it starts to germinate, is just above the level of the ground. Deep planting should be avoided.

THE most critical time for the palm is during the early stages of its life, that is, from time of planting to the third or fourth year; it is only by careful attention during this period that early maturing and good bearing palms are likely to result. After planting, the ground around the young palms should be clean weeded, and no grass or other weeds should be allowed to interfere with their growth. To develop the feeding roots, the surface soil at the base of the palm should be kept in a friable condition by digging or forking at least once every three or four months.

Coconut Estate, shewing Young "Supplies."

As an alternative to clean weeding, leguminous cover crops may be established in the first year of growth. These will reduce the cost of weeding and, at the same time, increase the fertility of the soil. When the young plants begin to develop, growth may be further improved by surface cultivation with ploughs or disc harrows. On peaty land, where the soil is apt to subside after it is opened up, mounding or banking the young plants is often necessary, and this operation may have to be continued until the land has settled down to its normal level. On low-lying land, drainage operations will have to be carried out, as the coconut palm will not thrive in a water-logged soil.

Pests and Diseases.—The coconut palm is fairly free from the attacks of insect pests and diseases. The worst pests are the red-stripe weevil (*Rhynchophorus schach, Oliv.*), the black beetle (*Oryctes rhinoceros, Linn.*), and the caterpillar of a moth *Artona* (*Brachartona*) *catoxantha, Hamps.*, whilst the chief diseases are sporadic cases of bud-rot and the leaf-spot caused by *Pestalozzia palmarum.*

Yields.—The coconut usually comes into bearing between the fourth and sixth year after planting, and may continue to bear good crops of fruit for sixty years or more. When the trees come into bearing, the ripe nuts are collected every two to two and half months, which gives five to six pickings during the year. A good palm in full bearing will yield as many as 80 to 100 nuts, but the average is about 50 nuts per palm per annum, or approximately 2,500 nuts per acre per annum.

Nuts for making copra should only be collected when fully ripe. After harvesting, the nuts should be allowed to remain unhusked for about two weeks;

the fibrous husk is then removed, and the nuts split open with a sharp knife. The kernel or meat is removed from the shell and dried in the sun, or in special kilns artificially heated. The latter method is both quicker and cleaner. The dried product is known as copra. Usually from 230 to 250 nuts are required to produce a picul* of copra, equivalent to about 4,000 nuts to a ton of copra.

The Dwarf Coconut.—The Dwarf or King coconut, which is known locally as "Nyiur Gading" has recently attracted considerable attention as a possible new enterprise. Only one estate has, so far, attempted its cultivation on a large scale, and it is still doubtful whether the results obtained will justify the returns which are anticipated, or even bear comparison with those of the commonly cultivated tall variety.

THE Dwarf variety is usually planted 22 ft. x 22 ft. square, giving 90 trees per acre, and comes into bearing at about the third year after planting. The average yield at six years is stated to be 80 nuts per palm per annum. The nut is smaller, and the kernel thinner, than that of the ordinary variety, with the result that, on the average, 500 nuts are required to produce a picul of copra.

THE chief advantages of the dwarf coconut are that it is hardy, matures early and is very prolific; but its main drawback is the small size of the fruit, which necessitates the handling of about twice the number of nuts per picul of copra as compared with the tall variety.

*** 1 picul = 133⅓ lbs.**

Extraction of Oil.—Copra is rich in oil, containing from 68 to 72 per cent. of oil, which, when extracted, is known as coconut oil. As the cake remaining after the extraction of the oil is a valuable ingredient of feeding stuffs, coconut oil is almost invariably obtained by the method of expression, the yield of oil obtained under these conditions being about 62 to 64 per cent. on the copra.

BEFORE being pressed the copra is treated in a special machine known as a disintegrator, which breaks it up into small pieces, after which it is passed through crushing rolls to reduce it to a fine state of division. Owing to its high oil content, the meal is heated and pressed twice. In some cases expellers are used for the first expression. The second expression is always carried out in a hydraulic press, preferably of the cage type.

Desiccated Coconut.—Although the attention of coconut plantations in this country is confined chiefly to the production of copra, a small industry has recently been started for the manufacture of desiccated coconut.

IN the manufacture of this product, the kernel is removed from the nut while quite fresh and, after the brown skin on the surface has been cut off, shredded and dried in hot-air ovens at a temperature of about 160° F. The dried product is then graded and packed in boxes for export.

Uses.—Coconut oil is without doubt the most economically important vegetable oil, and is used in enormous quantities throughout the world in the manufacture of substitute butters, such as margarine, other edible fats, soaps and candles. In addition, wherever the coconut palm is to be found,

large quantities of this oil are prepared locally by the natives for their own consumption, this being the favourite oil for general purposes such as cooking and, to a less extent, for toilet purposes and as an illuminant.

As stated above, the residue remaining after the expression of the oil forms a valuable feeding stuff for cattle. Desiccated coconut is used as a food-stuff, principally in confectionery.

In addition, coir ropes, mats, brooms and brushes may be made from the fibre obtained from the husk; but in Malaya, at present, the husk is either burnt as fuel for the copra kiln or returned to the soil to rot. The shells are also used as fuel for the drying kilns.

Alcohol can also be produced by fermenting the sap obtained by cutting periodically the unopened flower spathe of the palm and collecting the liquid which exudes. This liquid, when fermented, as is well-known, is the favourite beverage of the Tamil coolie.

Exports.—(a) *Copra.* The following table shows the exports of copra from the Straits Settlements for the period 1919 to 1921.

Year.	*Quantities.* Piculs.	*Value.* $ *
1919 ..	1,912,647	33,776,114
1920 ..	1,994,098	45,753,153
1921 ..	2,259,996	27,619,578

* $1 (Straits currency) = 2*s.* 4*d.*

THE above figures include, however, large quantities of copra imported into Singapore and Penang for re-export, in each case amounting to approximately half the total quantity exported.

THE principal countries to which exports of copra were made during the year 1921 were as follows:—

Countries.	*Quantities.*	*Value.*
	Piculs.	$
Netherland ..	737,547	8,809,591
Germany ..	529,769	6,590,893
France ..	358,600	4,401,679
United Kingdom	246,581	3,115,332
Spain ..	209,198	2,414,552
Denmark ..	106,022	1,325,530

(b) *Coconut Oil.* The production of coconut oil in Singapore and Penang, where there are a few mills engaged in this industry, is fairly considerable, the exports in 1921 being valued at $3,788,223 compared with $5,786,569 in 1920.

THE principal countries to which this oil is exported are Sumatra and Siam, whilst large quantities are consumed locally in the Malay States.

(c) *Coconuts.* In addition to the export trade in copra and coconut oil, small quantities of whole coconuts are exported from the country; the value of such nuts exported during 1921 was $373,850 against $463,650 in 1920.

General.—The cultivation of the coconut under suitable conditions can be safely expected to give steady, though small, returns; with good management, a profit of ten or even twenty per cent. on the capital outlay involved is possible with copra at about $12.00 per picul.

THE present market price of copra in Singapore (October, 1923) is quoted at $11.00 per picul, whilst the latest London quotations (September, 1923) for the various products are as follows:—

Copra (Straits)	..	£24 per ton.
Coconut oil	..	£38—£47 per ton.
Coconut oil cake	..	£ 7—£ 8 „
Coconut (desiccated)		37/- per cwt.

AFRICAN OIL PALM.

(*Elaeis Guineensis*).

THE African oil palm, the fruit of which yields the two well-known oils of commerce, palm oil and palm kernel oil, was introduced into the Netherlands Indies in 1848, but did not receive serious consideration as a plantation crop until the last decade.

DURING this period considerable progress has been made in the Dutch East Indies where, according to Rutgers, the area planted with oil palms on the east coast of Sumatra had increased from 8,500 acres in January, 1918, to 28,000 acres in January, 1922.

ATTENTION is also being given to the cultivation of this crop on a plantation scale in this country, the area planted to date being estimated at about 5,000 acres, of which 1,000 acres are in bearing. The export of palm oil and palm kernels has already commenced. Numerous applications for land have recently been made which shows that the possibilities of the crop are now being realised by the local planting community.

Varieties of Oil Palm.—Although different varieties of *Elaeis Guineensis* have been described, based primarily on the form and composition of fruit, it

African Oil Palm (Elaeis Guineensis).

Artificial Pollination of Oil Palm.

is somewhat doubtful whether there are any definite fixed types, and breeding experiments will have to be carried out to determine this point.

THE " Deli " type, which is in general cultivation in Sumatra and this country, is considered to be most suitable to the local conditions, and it is doubtful whether it will be superseded by other varieties introduced from West Africa, where the palm is indigenous.

THE composition of the fruit may vary (a) in the percentage of pericarp and its oil content, (b) in the percentage of kernel and its oil content, (c) in the thickness of the shell enclosing the kernel. Improvement may be brought about by selection work on the existing varieties, the main objects being to produce a type with fruit giving (a) the maximum amount of pericarp with a high oil content, (b) a thin shell with the maximum amount of kernel of high oil content. In selecting parent trees, allowance will have to be made for alteration in type due to external environment, which may have a greater effect than genetic constitution.

Cultivation.—The general cultivation of the oil palm is similar to that already described for the coconut, and the conditions both as regards soil and climate appear to be much the same for both crops.

THE most suitable soil for the African oil palm is an alluvial loam over-lying a clay subsoil, which will permit of easy root penetration and retention of moisture. Light sandy soil or swampy land is unsuitable. Although it may be grown successfully on gently undulating land, the flat coastal land, provided it can be properly drained, is likely to give the best results.

THE oil palm is propagated from seed, the time taken for germination varying considerably, depending both on age and method of treatment in the propagating beds. Seeds imported from West Africa, which have dried up, or those which are either unripe or overripe, germinate very slowly; whilst even good ripe seeds obtained locally, when sown as fresh as possible, may by no means germinate rapidly. This is a serious drawback when a definite planting programme has been arranged and, therefore, special attention must be given to the method of propagation in order to accelerate germination as much possible.

THE most satisfactory method of germination is to collect only ripe seeds and, after removing the pericarp, to sow them at once, just below the surface, in specially prepared beds consisting of pure sand about 1 foot deep. The beds are exposed to the full sun and are kept moist by constant watering. Immediately the two leaf sheaths appear above the surface, the seedlings are removed from the sand beds and planted out about 1 to 1½ ft. apart in specially prepared nursery beds on good flat land. The seedlings remain in these beds until ready for transplanting into the field, which may be from 8 to 10 months according to the season when they were planted out in the nursery beds.

THE most suitable distance of planting in the field is 30 ft. x 30 ft. triangular (equilateral), which gives approximately 55 palms per acre. The area to be planted is lined and holed in the same way as that recommended for coconuts. The oil palm stands transplanting fairly well under ordinary conditions and, therefore, very little supplying should be necessary. After planting, the land should be either

clean weeded, or a suitable leguminous cover crop established. In cases where planting is carried out on undulating land, steps should be taken to prevent soil wash, which is best done by (a) planting low-growing cover crops, (b) silt-pitting, or (c) terracing, all of which tend to arrest the erosion of the surface soil by diminishing the force of rain water which carries away the finer particles of the surface soil.

ALTHOUGH catch crops are not generally recommended, those of a temporary nature are sometimes cultivated in the early stages of development in order to provide a certain amount of revenue. On areas where the soil is suitable for the cultivation of coffee, Robusta or its hybrid varieties may be grown with a certain degree of success.

WHEN the palms come into bearing, at the end of the 3rd. or 4th. year after planting out in the field, it will be necessary to commence a regular system of pruning the leaves at the base of the palm. The leaves immediately below the growing bunches of fruit should not be removed until the fruit is almost ripe and ready for harvesting. The pruning operation should be carefully carried out, since the total fruit production of heavily pruned trees decreases very rapidly when compared with those pruned normally. Pruning is now practically restricted to cutting off those leaves which have a ripe bunch in their axils.

Pollination.—Observations on young or isolated palms have shown that natural pollination does not always take place, which has led to experiments

being conducted on artificial pollination. The male and female inflorescences are produced on the same palm but not necessarily at the same time and, as the flowers on the female inflorescences remain in a receptive condition for a period of only two days after the opening of the flowers, it is frequently necessary to obtain pollen from a male inflorescence on another palm, otherwise the flowers may not be fertilised.

WHERE artificial pollination is necessary, a ripe male inflorescence, denoted by its strong smell of aniseed, is selected; after careful removal from the palm, it is held over a specially made funnel and shaken so that the pollen grains fall into a suitable receptacle placed under the funnel. The pollen should be collected in the afternoon and, the following morning, is dusted on to the female inflorescences ready for pollination.

WHILE artificial pollination may be advisable in the case of young palms, it may be found unnecessary in the case of older ones, which may be sufficiently pollinated by natural agencies. Experiments in artificial pollination have shown that it can be overdone, but it remains to be determined to what extent it can be carried out successfully in actual practice over a continuous period. In some cases, more particularly on poor land, over-pollination by artificial methods has resulted both in the reduction of the size of the fruit and the percentage of pericarp.

Pests and Diseases.—So far, the oil palm does not appear to have suffered greatly from the attacks of insect pests or fungoid diseases; but, with an

increased area under cultivation on a plantation scale, quite different conditions would prevail, the risk of both pests and diseases naturally becoming greater.

AMONG insect pests, the coconut beetle (*Oryctes rhinoceros, Linn.*) and the red-stripe weevil (*Ryhnchophorus schach, Oliv.*) have been found doing damage, the latter having been known to kill palms by boring through the main stem.

THE only disease so far reported, which appears to be confined to young palms, is the "crown disease." This is a weakening of the leaf stalk of the young leaves, which become bent and fall over, giving the crown a twisted appearance. As a rule, after some time, new leaves are formed and the palm recovers its normal appearance.

OTHER pests which may be mentioned are rats, pigs, and porcupines, which must be exterminated by the usual methods, such as poisoning, trapping or killing in some other way.

Harvesting.—As previously stated, the palms come into bearing at about the 3rd. or 4th. year after planting, and the fruit ripens about 6 months after pollination. The crop is not evenly distributed over the different months of the year, the maximum crop being obtained in the dry season and the minimum in the wet season; the maximum production per month is about double the average monthly production.

THE fruit bunches should be gathered systematically as soon as they are ripe, and carried to collecting sheds. Here they are stored on open racks for three or four days until the friuts fall from the bunch on to the trays below. The loose fruit is then collected and transported to the factory, where the oil is to be extracted. Great care is necessary in the handling of the fresh fruit; in no circumstances should it be allowed to remain in heaps, otherwise it will ferment, resulting in a large increase in the acidity of the oil.

Composition of Fruit.—The following table shows approximately the average composition of the fruit grown locally:—

FRUIT
- Pericarp 58 per cent. ... ... — Moisture 33 per cent. / Palm Oil 53 „ / Residue 14 „
- Nut 42 „ — Shell 85 per cent.
  - Kernel 15 „ — Moisture 15 per cent / Palm K. Oil 43 „ / Residue 42 „

Proportion of Palm oil on whole fruit = 31 per cent.
„ „ Kernel oil on „ „ = 7 „ „

Yields.—Individual palms may produce from 6 to 10 bunches per annum, whilst the weight of picked fruit may vary from 75 to 150 lbs. per palm per annum according to age. With palms planted 55 to the acre, a fair estimate of the annual production would be 1,250 lbs. of palm oil and 330 lbs. of kernels per acre in the sixth year, increasing to 2,400 lbs. of palm oil and 650 lbs. of kernels per acre in full bearing.

the flesh or pericarp, and palm kernel oil, contained *Extraction of Oil.*—The African oil palm fruit contains two distinct oils, namely palm oil, present in in the kernel. As previously stated, the treatment

of these fruits calls for special attention as there is present in the pericarp an active fat-splitting enzyme or non-organised ferment; it is of the utmost importance that the fruit be picked when ripe and treated while still fresh, otherwise a large part of the oil will be decomposed, with the formation of an abnormal proportion of free fatty acids. With care, this acidity can be kept below 5 per cent.; but, if the fruit be allowed to lie about, and the oil extracted in the primitive native method by boiling out with water, it may contain up to 50 per cent. of free fatty acids.

THE method usually adopted to obtain palm oil of high quality consists in a preliminary heating of the fruit to destroy the ferment, and subsequent pressing while still hot, in order to obtain as much of the oil as possible without cracking the nut. The pericarp is then stripped from the nuts in a special machine known as a depulper or depericarper and, after drying, is pressed again to obtain the remainder of the oil. The residue is used as fuel, having no value as a feeding stuff or fertiliser.

MENTION might also be made of a modification in this method involving the use of a centrifugal extractor. In this modified process, the fruits are steamed and depericarped without any preliminary pressing, after which the mass is charged into the extractor, in which is removed the greater portion of the oil and moisture. The centrifugal action also facilitates the separation of the nuts from the fibrous residue, which is then pressed again as described in the previous process.

THE oil is then allowed to settle, and is strained into casks ready for export. Care must be taken in the selection of the wood for the casks, oak staves

being preferable in order to minimise the loss arising through leakage. Casks of standard size are employed, 10 tons of oil requiring about 15 casks.

AFTER separation from the fibre, the nuts are dried and then cracked by a nut-cracking machine, the kernels being separated from the shells by flotation in brine or clay suspended in water. The kernels are then dried for export, the shells being used as fuel.

THE expression of the oil from the kernels is carried out in a similar way to that already described for copra, the kernels being ground and hot-pressed twice in order to obtain the maximum yield of oil. The residue known as palm kernel cake is used as a feeding stuff.

Uses.—Palm oil finds a varied application in industry according to its free fatty acid content. While an oil of medium quality is largely employed in the manufacture of soaps, lubricating greases and candles, an oil with a minimum quantity of free fatty acids, from 2 to 4 per cent., can be used for edible fats. Hitherto, the quantity of such high grade palm oil available has been limited; but, with regular supplies coming forward, it should be able to compete as an edible fat with either coconut or palm kernel oil, since it has been proved that high quality palm oil forms an excellent basis for the preparation of substitute butters.

AS stated above, palm kernel oil is used chiefly in the manufacture of edible fats, smaller quantities being employed in the soap making industry. Palm kernel cake is used as an ingredient of many feeding stuffs.

General.—From actual experience gained in the cultivation of the African oil palm in this country, it appears that it is a crop which is well worth developing on a plantation scale. The yields recorded locally are sufficiently promising to warrant the outlay of further capital for the development of this industry, and it is considered that the return on the capital invested will be at least equal to, if not greater than, that obtained from the cultivation of coconuts.

THE present London quotations (Sept. 1923) for African oil palm products are as follows:—

Palm oil (Lagos)	..	£32.10 per ton. *
Palm kernels	..	£16.10 „ „
Palm kernel oil	..	£35.10 „ „

MISCELLANEOUS OIL-YIELDING CROPS.

IN addition to the two main oil-yielding crops just described, there are several other oil-yielding plants which may be cultivated successfully in this country. Their cultivation, however, is never likely to be developed to such an extent as to cause them to be regarded as main crops, either because they are not suited to large scale plantation conditions or because the oil has only a limited industrial application. It is considered advisable to describe the cultivation of some of these plants as, in many cases, it will be seen that they are suitable for the smallholder.

* This figure does not apply to palm oil with a low free fatty acid content, for which a varying premium is paid.

FIXED OILS.

Groundnuts. (*Arachis hypogaea*).—This is an annual herbaceous plant the seeds of which yield, when expressed, the well-known groundnut or peanut oil of commerce. It is a plant which is cultivated extensively throughout the tropics, and one particularly suited to the requirements of a small holder.

THERE are a large number of varieties known to cultivation, the most common being the so called Mauritius, Senegal and Spanish types.

Cultivation.—The plant thrives best on sandy or loamy soils, heavy or stiff clays being unsuitable owing to the difficulty with which the pod stems penetrate the soil. It is essential that the land be clean and free from weeds before planting. The soil should be either changkolled or forked to a depth of about 6 inches and then made up into ridges from 1½ to 2 ft. apart. The shelled seed is then sown about 2 inches deep and 15 to 18 inches apart on the ridges. The best time for sowing is at the beginning of a rainy season. During the period of growth little cultivation beyond weeding is necessary.

Harvesting.—The crop matures in about 3 to 5 months according to the variety of the seed and the nature of the soil. When the stalks and leaves of the plant begin to wither, and the skin on the kernel has turned pink, the crop is ready for harvesting. After collection, the nuts should be throughly dried in the sun before being stored.

THE plant is rich in nitrogen, so that after the harvest the stalks and leaves should be ploughed in as a green manure.

Yields.—The yield varies considerably and may be from 1,000 to 2,000 lbs. of nuts per acre according to the conditions of soil and season.

Extraction of Oil.—The kernels contain from 43 to 48 per cent. of oil, which is largely used as an edible oil. For edible purposes, the oil is obtained by cold pressing, that obtained by subsequent hot pressing being used chiefly for soaps. The cake remaining after the expression of the oil forms a valuable feeding stuff, being rich in albuminoids.

THE approximate prices (Sept. 1923) are as follows: Groundnuts (undecorticated) £17.10 per ton, Groundnut oil £43 to £46 per ton and Groundnut cake £8 to £10 per ton.

Gingelly. (*Sesamum indicum*).—This is an annual herbaceous plant from 2 to 4 ft. high indigenous to Southern India and tropical Africa. There is a number of varieties, with differences in the colour of the seed, the most common being the black and the white.

Cultivation.—The plant can be cultivated successfully on moderately good soil providing this is well drained and has been brought to a fine tilth. The seed is sown broadcast, and is usually mixed with sand in order to facilitate even distribution. The crop is ready for harvesting in from 3 to 4 months, according to the variety. The time for sowing should be so arranged that the crop will mature in a dry period.

Harvesting.—When mature, the plants are cut off close to the ground, tied up in bundles and left to dry in a sheltered place. After a few days the

capsules burst and the seeds can be removed readily by beating out the heads. If the plants are allowed to become overripe before harvesting, the capsules will burst in the field with loss of seed.

Yields.—The yield is somewhat variable, from 500 to 800 lbs. per acre being considered a fair average under ordinary conditions.

Extraction of Oil.—The seed contains from 45 to 55 per cent. of oil, which is used largely for edible and medicinal purposes. The best quality oil is obtained by cold pressing, that obtained by hot pressing being used chiefly in soap making. The residue is used either as a feeding stuff or fertiliser.

THE current price (Sept. 1923) for Gingelly seed is £22 per ton.

Castor Oil. (*Ricinus communis*).—This is a tall growing shrub, the seeds of which are used for the preparation of the castor oil of commerce. There are numerous varieties, showing considerable differences both in the colour and size of the seed. It is a somewhat exhausting crop and requires a fairly rich soil, preferably low-lying alluvial flats. The plants begin to produce seed about 4 to 5 months from sowing, the harvest continuing for a few months dependent on both variety and season. The yield is very variable and a crop of from 500 to 1,000 lbs. of seed per acre may be obtained.

THE seeds contain from 45 to 50 per cent. of oil which is put to a variety of uses, being employed in the manufacture of soaps and lubricants, the dyeing and leather industries. In addition, castor oil is well-known for its medicinal properties, for

which purpose the oil should always be obtained by cold pressing. The cake remaining after the expression of the oil is poisonous and can therefore only be used as a fertiliser.

THE present prices (Sept. 1923) are as follows: Castor seed £19 per ton, Castor oil £49—£53 per ton.

Candlenut. (*Aleurites triloba syn. A. moluccana*). This is a tall-growing tree attaining a height of from 40 to 50 ft. The fruits contain hard-shelled nuts, the kernels of which have an oil content of about 62 per cent., equivalent to about 19 per cent. on the nut.

THE oil, which is obtained by expression, is a drying oil, somewhat inferior to linseed, and can therefore be used for more or less the same purposes, such as paints, varnishes and soft soaps.

THIS crop has so far only been cultivated in this country on an experimental scale and few details as to its possibilities are available.

Rubber. (*Hevea brasiliensis*).—This tree is too well-known to require description. The seed kernels contain about 42 per cent. of oil, equivalent to about 24 per cent. on the whole seed. Like candlenut, this oil belongs to the drying class, being also inferior to linseed oil. The seed contains an active fat-splitting enzyme or non-organised ferment and, to obtain a high grade oil, the seeds should be pressed either as soon as possible after collection or treated in some way to prevent the development of this free fatty acid. It might be mentioned that seed is only obtainable during about 3 months of the year. The oil cake appears to have considerable possibilities as a cattle food.

Kapok. (*Eriodendron anfractuosum*).—A moderate sized quick-growing tree, primarily cultivated for the fibre known as kapok. The seed contains about 20 per cent. of oil which is used to a certain extent, especially in Holland, for edible and soap making purposes. It is not a well-known oil, but it can be used for the same purposes as cotton seed oil; the cake, also, is a valuable feeding stuff. There is reason to expect that, with regular shipments of seed coming forward, the market for this oil will extend considerably.

Cotton. (*Gossypium spp.*).—Cotton seed is one of the most important of the world's oil-bearing seeds, in the same way as cotton is the most important of all known fibre plants. The seed contains about 20 per cent. of oil which, when refined, is used to an enormous extent in the preparation of substitute butters and edible fats, while the lower grades are employed in soap making and for a variety of other purposes. Cotton seed cake is one of the most common feeding stuffs, being particularly suitable for cattle.

So far, cotton has only been grown on a small experimental scale in this country.

THE current prices (Sept. 1923) are as follows: Cotton seed £9 to £11 per ton, Cotton seed oil £37 per ton.

Illipe. The so-called Illipe nuts, which are a forest product largely imported into Singapore from Borneo, Sumatra and other small islands of the Malayan Archipelago, are obtained from the fruits of various species of plants, among them being species of *Shorea* and *Isoptera* (N. O. Dipterocarpeae) and a species of *Palaquium* (N. O.

Sapotaceae). The fat content of the nuts shows considerable variation and may be from 40 to 60 per cent. The principal interest of the fat, which is known as Borneo tallow, is that, on account of its hardness, it is specially suitable for the manufacture of hard edible fats, being used in the preparation of chocolate. The fat from the *Palaquium* species, the nuts of which are known in the trade as Siak nuts, is used only for soap making.

Croton (*Croton Tiglium*).—This is a small tree or shrub, from the seeds of which croton oil is obtained. The seeds contain about 55 per cent. of oil, which has only a very limited market. It is employed chiefly in pharmacy.

THE present price (Sept. 1923) of Croton seed is about 30*s*. per cwt.

Cashew Nut. (*Anacardium occidentale*).—A spreading tree about 30 to 40 ft. high, bearing seeds, the kernels of which are edible, being used as a dessert nut and in the manufacture of sweetmeats. These kernels contain between 40 and 45 per cent. of oil, which, it has been suggested, might be utilised in pharmaceutical preparations in a similar way to almond oil.

Nutmeg. (*Myristica fragrans*).—The seeds of this tree yield about 40 per cent. of fat, yellow in colour, soft in consistency, and with a strong nutmeg flavour. This so called nutmeg butter is used to a very limited extent in the preparation of various medicinal ointments.

Roselle. (*Hibiscus sabdariffa* var. *altissima*). The seeds from this plant, which is cultivated primarily for its fibre, contain about 17

per cent. of an oil, which is similar to both kapok and cotton seed oils and could doubtless be used for the same purposes.

Chaulmoogra. (*Taraktogenos kurzii*).—The seeds from this tree yield chaulmoogra oil, which has been much used in the past for treating skin diseases and is now being employed as a cure for leprosy.

Native Oils. In addition to the foregoing, there are to be found, used by the natives in various parts of the country, other fixed oils amongst which might be mentioned "Buah Prah" (*Elateriospermum Tapos*), Kapayang (*Pangium edule*), and Calophyllum oil (*Calophyllum Inophyllum*).

As these trees are generally so scattered, and the quantities of the various oils available so small, they are not likely to be of any economic importance.

ESSENTIAL OILS.

Citronella. (*Cymbopogon Nardus*).—A coarse grass, 3 to 4 ft. high, largely cultivated for the production of the essential oil which it contains. The grass can be propagated readily from root divisions, which are planted in rows 2½ to 3 ft. apart, and the first cutting of grass can be made at about 8 months from the time of planting, after which it can be cut twice a year. Cuttings may be continued for a period of 8 to 10 years, when the grass must be replanted. A yield of about 5 tons of fresh grass per acre is obtained at each cutting.

THE extraction of the oil is carried out by the steam distillation method. After cutting, the grass is allowed to dry for a few days before distillation in order to save fuel, and therefore the harvest should be arranged to take place during a dry spell. The yield of oil is highest with young grass, when it may be as high as 0.8 per cent., while with old grass it may be as low as 0.3 per cent. On a basis of two cuttings a year and an average oil content of 0.5 per cent., the yield of oil is about 110 lbs. per acre per annum.

THERE is a steady demand for this oil, which is largely used for scenting soaps and for the manufacture of various artificial perfumes. The oil from this country, which is slightly superior to that produced in Ceylon, at present realises about 4*s*. 3*d*. per lb. (Sept. 1923).

Lemon Grass. (*Cymbopogon citratus*).—This grass is somewhat similar to citronella in appearance, although not so strong in growth. It is propagated in the same way but is planted rather more closely, usually 2 to 2½ ft. apart. The grass is ready for cutting when about 8 months old, after which two cuttings a year can be maintained for some years. The yield of fresh grass usually obtained at each cutting is about 4 tons per acre. The extraction of the oil is carried out in the same way as that described for citronella. The yield of oil is much less, being only between 0.2 and 0.3 per cent., calculated on the fresh grass, which is equivalent to about 45 lbs. per acre per annum.

AT present, there is little demand for this oil, which is used in the preparation of artificial perfume. The current price (Sept. 1923) of the oil is about 2¾*d.* per ounce.

Patchouli. (*Pogostemon spp.*).—Patchouli is an herbaceous plant, about 2 to 3 ft. high, cultivated for the essential oil contained in the leaves. The plant is propagated by stem cuttings planted in carefully shaded nursery beds; when rooted, these are transplanted in the open at distances of 2 to 2½ ft. apart. The first crop of leaves may be made about 6 months after planting out in the field, and subsequent pickings may be made twice a year. It is customary to replant about every two years.

THE leaves, after cutting, must be dried in the shade, care being taken to ensure that they do not become mouldy during the process. When dried, they may be either packed in bales for export, or steam distilled according to the method already described.

IT is stated that the dry leaves yield by distillation between 2 and 4 per cent. of oil, which is used entirely as a perfume.

THE present price (Sept. 1923) of the oil is about 28*s.* per lb.

Vetiver. (*Vetiveria Zizanioides*).—A perennial grass, about 4 ft. high, which yields from its roots by steam distillation the vetiver oil of commerce. The leaves of the grass are without odour. The grass is propagated by root cuttings similar to citronella, and planted in rows 2½ to 3 ft. apart. The plants are ready for lifting after 9 to 12 months. The roots are washed to remove adhering soil and dried in the sun. To obtain the

oil the dried roots are steam distilled. The oil is very viscous and the distillation is therefore lengthy. The yield of oil is about 0.5 per cent. calculated on the fresh air-dried root.

VETIVER oil is used exclusively in perfumery on account of its fixing properties, since it prevents other essential oils from volatilising too rapidly. The present market price (Sept. 1923) of the oil is about 21*s.* per lb.

Limes. (*Citrus acida*).—A small spiny tree producing the well-known lime fruits which, in addition to being used as fruits, are also employed for the manufacture of concentrated lime juice and citric acid.

DURING the process, the essential oil contained in the rind of the fruit is recovered, partly as an expressed oil and partly as a distilled oil. The expressed oil is obtained by treating the fruits in an ecueille as previously described, while the distilled oil is recovered when the first concentration of the raw juice, obtained by crushing the fresh fruits, is carried out.

OIL of limes is used in perfumery, as a flavouring for essences and confectionery, and in the preparation of scented soaps.

THE present market prices (Sept. 1923) of the oils are: Expressed 7*s.* 6*d.* per lb., Distilled 3*s.* 6*d.* per lb.

Cloves. (*Eugenia caryophyllata*).—A small conical tree yielding the cloves of commerce, which are the dried unopened flower buds. It is only, however, the inferior grades of cloves which are used for the production of the oil.

THE cloves are steam distilled to obtain the essential oil, the yield being from 15 to 18 per cent.

OIL of cloves is used principally as a flavouring, but also to some extent in medicine and microscopy.

THE present price (Sept. 1923) of the oil is about 7*s.* 6*d.* per lb.

Nutmeg. (*Myristica fragrans*).—This is a bushy tree about 30 ft. high, which is cultivated for the nutmeg and mace of commerce.

THERE is a small demand for the essential oil, which is obtained by steam distillation of the crushed nutmegs, the yield of oil being from 8 to 10 per cent.

NUTMEG oil is used almost entirely as a flavouring agent.

THE current price (Sept. 1923) of the oil is about 4*s.* 6*d.* per lb.

CONCLUSIONS.

ALTHOUGH it will be seen from the foregoing information that there is a large number of oil-yielding plants which can be cultivated in this country, yet the development of many of them on anything but a small scale is not possible.

IN the first place, there is only a limited demand for many of these oils, and any considerable increase in production would result in an overloading of the market, with a corresponding reduction in price.

In the second place, many of these crops need a surplus of labour in the country, available at any time for the limited periods of planting and harvesting. This surplus is unfortunately not available in Malaya.

WITH crops such as coconuts and African oil palm, which produce more or less continuously throughout the year, these difficulties are obviated, as there is a steady demand for the products and a permanant labour force can be kept employed.

Fibres.

Fibres.

THE fibres of commerce are classified usually as hard or soft according to their texture and uses, their application depending partly on their texture and also on other qualities, principally capacity for spinning.

ONLY about twelve of the large number of known fibres in the world have been utilised commercially.

FLAX has been in use for centuries, while hemp (*Cannabis sativa*) was utilised later, but long before some of the tropical fibres now in use.

THE principal hard fibres of commerce, which are derived entirely from plants, are Manila, Sisal, Mauritius, Bowstring and New Zealand hemp. These fibres are used almost entirely in the manufacture of cordage, i.e. ropes, twine, etc. The increasing use of mechanical harvesters for the harvesting of cereal crops has absorbed a large quantity of the hard fibres in the form of binder twine.

AT the present time the world's consumption of hard fibres is over 350,000 tons.

THE following figures for the year 1915 are of interest and show the principal countries of origin of the chief hard fibres:—

		Tons.
Philippines	Manila Hemp or Abaca (*Musa textilis*)	140,000
Java	Manila Hemp ..	600
Mexico	Henequen (*Agave fourcroydes*)	135,000
Cuba	„ (*Agave fourcroydes*)	3,000
Java	Sisal (*Agave rigida* var. *cantula*)	6,500
Bahamas	„ (*Agave rigida* var. *sisalana*)	4,300
B. E. Africa	„ (*Agave rigida* var. *sisalana*)	3,750
Hawaii	„ (*Agave rigida* var. *sisalana*)	1,000
Portuguese E. Africa	„ (*Agave rigida* var. *sisalana*)	600
New Zealand	New Zealand Hemp (*Phormium tenox*)	23,225
	Total ..	317,975

IN 1913 German East Africa exported 20,000 tons of Sisal hemp.

IN Mauritius and a few other countries, Mauritius hemp (*Furcraea gigantea*) is cultivated on a small scale, but is said to be less suitable than Sisal, also the percentage of fibre in the leaves is lower than in the case of Sisal.

BOWSTRING hemp (*Sansevieria spp.*) is at present a jungle product, but appears to offer possibilities as a subsidiary crop on old rubber estates.

THE soft fibres, which are used in the manufacture of textiles of different quality, include flax, jute, hemp, cotton, kapok, silk and wool, of which the first five are derived from plants.

ROSELLE fibre, which closely resembles jute, is discussed in this article, since a serious attempt is being made to establish the cultivation of this fibre plant in Malaya. At present it is not one of the commercial fibres of the world, and its market value and possibilities have not yet been established.

DURING the war period the price of fibres rose enormously but at the present time there is considerable fluctuation and prices have decreased.

THE experimental cultivation of Sisal and Mauritius hemp has been carried out for several years by the Department of Agriculture, but no yields have been recorded. Samples of Mauritius hemp have been reported on favourably and a specimen of Bowstring hemp prepared at the Department of Agriculture has been valued recently at £40 per ton, while samples of Roselle fibre have been valued at £20 per ton for uncombed, and £30 per ton for combed fibre.

MANILA hemp, Sisal hemp and Mauritius hemp can all be grown in Malaya and appear promising, although no definite information is available as to the probable profits.

IN the marketing of fibres, considerable care and attention has to be paid to grading and baling. In the case of Manila hemp there are about ten grades

on the market; and in the Philippines, from which the greater part of Manila hemp is derived, a Government grading staff exists for this purpose. The establishment of such a staff would only be justified if large areas were grown.

SISAL and Mauritius hemp can be prepared by retting, but the fibre is usually extracted in special decorticating machines, since the decorticated fibre is said to be stronger and better. Consequently it is necessary to establish large plantations, in order to run a factory economically. Since the proportion of fibre in the leaves is only three to four per cent., it is not economical to transport the leaves for a long distance to central factories. Manila hemp and Roselle fibre are prepared by hand, and small areas can be cultivated economically.

FIBRE machinery can be purchased from the following firms:—

Messrs. Marshall & Co., Gainsborough, England.

Messrs. Robey & Co., Ltd., Lincoln, England.

David Bridge & Co., Castleton Iron Works,
Castleton, Lancashire, England.

Ernest Lehmann, 8, Chatham Buildings,
Chatham Street, Manchester, England.

Prieto Machine Co., Inc., 45, Broadway,
New York, U.S.A.

A complete plant for fibre extraction consists of a decorticating machine, crushing rolls for thick and hard leaves, a brushing machine and a baling press, with necessary prime mover in the form of a steam, oil or gas engine or motor, shafting, belting etc., and a building of a suitable size.

A decorticator can produce about 400 to 500 tons of fibre per year, representing leaves from 400 to 500 acres, and one machine is sufficient for 1,500 acres in the case of Sisal.

FIBRES for export must be baled under pressure to save excessive freight charges. A suitable weight for bales of fibre is about 2 cwt., and the fibre should be pressed so that a ton occupies 70 cubic ft.

DETAILS of cost of factories for the extraction and baling of fibre can be obtained from the Department of Agriculture, F.M.S. and S.S.

SISAL HEMP.

(*Agave rigida* var. *sisalana*).

THERE is a large number of varieties of Agave (Sisal), but only three are in general use, viz., *Agave rigida* var. *elongata* (Mexican Sisal), *Agave rigida* var. *sisalana*, and *Agave cantula*. The last named is said to stand a higher rainfall, hence its success in Java.

THE sisal plant is propagated from the small plants known as "bulbils" that arise in the axils of the flower-stalks or from suckers from the rhizome; the latter source is recommended.

Nurseries. The bulbils or suckers are planted in nurseries, which should be tilled to a depth of about one foot, the beds being about four feet wide, with one foot paths between. The bulbils or suckers are spaced nine inches apart in the nursery beds. Shading is unnecessary and watering seldom required; weeding, however, is important. The plants are generally kept in the nurseries for about one year. Suckers may also be detached from

the parent and planted direct in their permanent quarters. Bulbils can be supplied by the Department of Agriculture from time to time at a cost of one cent each; approximately 900 are required per acre.

Planting and Cultivation. The most suitable soil is a fairly dry, permeable, sandy loam, containing a small amount of lime. Good drainage is essential as the roots of the plants are liable to be damaged by standing water. On poor soils, the plants make inferior growth, but are said to contain a larger proportion of fibre than plants grown on too rich land. Hilly land is well suited for sisal cultivation as it allows of easy drainage. It is not necessary to break up the land, but all undergrowth must be removed. Holes, one foot deep, are made in rows eight feet apart, six feet apart in the rows, which allows about 900 plants to the acre. Planting should be undertaken during the rainy season, all fibrous roots and lower leaves having been first removed to facilitate new growth.

SYSTEMATIC weeding is necessary throughout the period the crop occupies the land. Light tillage to a depth of three or four inches is recommended when the clearing is about one year old; subsequent tillage is unnecessary.

Harvesting. The period before harvesting varies; but, in general, cutting commences within three years of planting out, or about four years from the planting of the bulbils in the nursery. The leaves, when ready for cutting, are removed close to the trunk, care being taken not to injure the younger leaves of the plant. The number of leaves which can be cut per annum varies consider-

ably; in Mexico twenty-five is the average, whilst in East Africa double that number is obtained. The estimated yield under good conditions is from 1,000 to 1,200 lbs. of dry fibre per acre; one ton of raw leaf will produce between 60 and 80 lbs. of dry fibre.

THE duration of life of the plant is determined by the production of the pole or inflorescence, the average length of life in Malaya being about eight years. This is a much shorter period than is the case in Mexico and is chiefly due to the local climatic conditions. It is stated, however, that this is no disadvantage as the same total crop is produced in a relatively shorter time.

IN view of the fact that the raw leaf only produces from three to four per cent. of dry fibre, the cost of transport to a central factory would be prohibitive; it is therefore necessary to install machinery in the locality of the plantation. At least 1,000 acres should be planted to warrant the erection of a factory installation of the necessary machinery for the production of first quality fibre.

Preparation of Fibre. The leaves should be treated in special decorticating machines within 24 hours of cutting. A woman is said to be able to cut 600 leaves per day and a man 800.

A "Corona" decorticator is said to treat 100,000 to 150,000 leaves per day producing two to two and a half tons of fibre per 8-10 hours' day. The decorticated fibre is hung on poles to dry in the sun for two days, and is brushed in special brushing machines to remove any extraneous matter, pulp etc. A constant supply of good water is essential

for the factory. Sisal hemp fibre can be prepared also by retting by hand labour, but the fibre is said to be weaker than, and of inferior colour to fibre prepared by decorticating machinery.

A labour force of one coolie per two acres is said to be required, and a European Manager can supervise a large area comprising about 5,000 acres.

SISAL hemp is quoted at £36 per ton, August, 1923.

Agave cantula. The Henequin of Yucatan, *Agave rigida* var. *elongata;* the Sisal of Hawaii, *Agave rigida* var. *sisalana;* and the Maguey of the Philippine Islands, recently identified at the Royal Botanic Gardens, Kew, as *Agave cantula*, are very similar plants. All have the short, thick stem, the aloe-like cluster of large, fleshy leaves, and the tall flower-stalk or "pole," which bears a large number of small "bulbils," or pole plants. The Hawaiian plant differs from that of Yucatan in having a shorter trunk, leaves smooth-edged, or bearing a few unequal teeth, and the fibre less in quantity but superior in quality. *Agave cantula* is said to be variety cultivated in Java and prepared by retting.

MAURITIUS HEMP.

(*Furcraea gigantea*).

MAURITIUS Hemp is very similar in habit of growth to Sisal Hemp; in cultivation it is also very similar, except that the former is planted a little wider apart, say eight feet by eight feet. The method of preparation of this fibre is similar to that of Sisal. THE quality of Mauritius hemp is not so good as that of Sisal and therefore it has a lower market value.

It can be propagated only by "bulbils," since no suckers are produced.

Recent experiments carried out at the Department of Agriculture to determine the percentage of fibre produced from freshly cut green leaves of various varieties of hemps have yielded the following results:—

	Dressed fibre. per cent.	Total fibre. per cent.
Furcraea gigantea (old plants)	1.82	2.24
„ „ (young plants)	2.74	3.28
Agave rigida var. *sisalana*	3.79	4.49

The fibre was extracted in each case after the leaves had been retted for eighteen days.

These results show that Sisal produces a larger percentage of fibre than Mauritius, also that the young Mauritius produces a higher percentage than the old, indicating that it is unprofitable to allow Mauritius to become too old before cutting.

The higher percentage of fibre produced by Sisal as compared with Mauritius, together with the fact that the former commands a higher price in the market, points to the advisability of growing Sisal.

It must, however, be noted that Mauritius produces a heavier crop of leaves per acre, and the question which remains to be decided is, which class of fibre is the more profitable under Malayan conditions? This will depend on which makes the better growth in any locality, due allowance being made for the heavier charges for handling the Mauritius.

BOWSTRING HEMP.

THE herbaceous plant Bowstring Hemp has succulent leaves, blotched with gray and attaining a height of from two to three and a half feet or more. This plant yields fine, white, tough and elastic fibre. It is commonly found as an ornamental plant in gardens, and is well distributed throughout Malaya. It is indigenous to India and Ceylon, and is to be found growing in a large variety of soils, but thrives best in those which are fairly friable, and under partial shade throughout its period of growth; it appears to do well under the shade of old rubber.

THE plant is propagated by seed, division, or leaf cuttings, the latter being more convenient. The distance of planting is about two feet apart each way. The yield is reported to be one and a half tons per acre, as a sole crop.

THERE are many species of *Sansevieria*, the leaves of which yield a fibre suitable for cordage manufacture, found in most tropical countries. There are two very common types to be found locally. These plants have large, thick, underground stems or rhizomes which throw out numerous branches. The leaves arise from the base of the plant and vary in length. They are of a succulent nature, generally flat and wide, but some are thick and narrow.

A sample of fibre prepared from locally grown plants was forwarded to London and reported on as follows:—

"A hard, clean fibre; strength, good; height, fair; colour, dull white; preparation, good; texture, fine; value £40 per ton. (7—10—21)."

It was pointed out that small quantities would be more difficult to sell than larger quantities, as manufacturers would not care to touch it, unless they could get supplies on a fairly large scale, say 1,000 tons.

Fibre is extracted from the leaves by methods similar to those employed in the preparation of Sisal Hemp. The material is usually shipped in bales of four to five cwt.

The chief objection to this plant is that it is an extremely slow grower; on this account it is doubtful if it would pay to grow it commercially.

MANILA HEMP.

(*Musa textilis*).

Manila Hemp is derived from the sheathing leaf-stalks of *Musa textilis*. The plant requires a loose, moist soil, rich in humus and well drained, and appears generally well suited to Malayan conditions; it will not thrive on swampy land, or land liable to damage by surface wash. Manila Hemp is propagated by means either of root cuttings, or more commonly from the suckers which arise at the base of the parent plant; but sometimes it is grown from seed, the latter taking longer to reach maturity. Seed must be collected from fruits which have not become over-ripe.

Planting. Plantations are usually established by means of suckers planted out when about three feet high and spaced 8 to 9 feet apart. Holes are made 2 feet each way and left exposed to the influence of the atmosphere for a time. Previous to planting, the holes are filled in with the rich surrounding soil.

Cultivation. Subsequent tillage, beyond weeding, is unnecessary. The estate must always larly the former; consequently, recently cleared be kept free from lalang. Manila Hemp responds well to the application of potash and lime, particu- jungle land is usually suitable for its cultivation

Harvesting. The stems are ready to be treated for fibre just before the plants begin to flower, when they are cut about a foot from the ground and the leaves removed.

EACH stem is then stripped into its component layers. The outer leaf-sheaths contain a coarser and stronger fibre than the inner, while the fibre from near the middle is of a fine silky texture. Inferior grades are suitable for paper manufacture.

Preparation of Fibre. In preparing the fibre, each strip is taken by hand, and drawn between a blunt knife and a smooth board attached to a light frame. The fibre is then dried in the sun and packed in bales for shipment.

THE first crop is obtained two years after planting, and a full crop in the fourth year, plantations continuing to yield for about fifteen years. The usual return is said to be from 600 to 850 lbs. of dry fibre per acre, from the fourth year; but, with good cultivation, the yield could be increased; half a ton per acre is usually regarded as very satisfactory.

MANILA Hemp has been grown at the Kuala Lumpur Gardens for some time, and the results thus far obtained, on even comparatively poor land, are extremely promising. The original suckers were procured from the Philippines and represent one of the commercial varieties grown there.

THIS fibre might be grown by the small holder, since Manila Hemp is prepared by hand labour, and there would be little difficulty in securing a market for this well-known product. The Department of Agriculture, S.S. and F.M.S., will not be in a position to supply suckers for some considerable time, as all its material is at present required for large scale experimental purposes. It is estimated that fifteen suckers can be obtained per plant annually, and it is hoped that the Department will be able, in time, to supply a large number for planting purposes. Suckers can be obtained from Manila at a cost of a $190.00 gold per thousand, and the Department can furnish addresses of growers. Manila hemp is quoted at £31.10.0 per ton, September, 1923.

ROSELLE FIBRE.

Hibiscus sabdariffa, var. *altissima*.

THERE are two varieties of *Hibiscus sabdariffa*, viz. *Victor* and *altissima*. It is from the latter that Roselle Fibre is obtained.

DURING the past two years a great deal of interest has been taken in this crop, the Department of Agriculture having distributed seed to nearly one hundred applicants, most of whom are cultivating it in a small way; there are, however, a few estates where it has been taken up on a commercial scale.

ROSELLE is well suited to Malayan conditions. As regards soil, it would appear to thrive best on friable loams, but it has been found to do well on soils varying from a sandy loam to a stiffish clay. Laterite lands are unsuitable. Well-drained flat land and gently undulating ground are equally suitable, but hill land is not recommended.

PLANTING should be carried out at the commencement of the wet season. The area selected must be cleared of all weeds, and the soil brought to a fine tilth by changkolling to a depth of 4 to 6 inches and breaking up the surface lumps of earth. This will provide an even seed bed for the reception of the seed. When weather conditions are favourable, the seed is broadcast at the rate of about 20 lbs. to the acre and lightly raked in. It is important to see that the land is thoroughly free from weeds previous to sowing as weeding, after this operation, is discontinued.

THE crop is usually ready for harvesting when the plant commences to flower—viz. about 3½ months from the time of sowing. It has been noted, however, that flowering is sometimes delayed considerably, in which case the crop should be cut not later than the end of the fourth month from sowing. The best time for cutting is after rain, as the bast then comes away more easily.

STRIPPING the bast from the wood is accomplished by hand-labour; preferably in the field, in order to save transport. The bundles of bast are brought to the retting-tanks, which should be situated near running water for the washing of the fibre after retting.

THE period of immersion in the retting-tanks varies slightly, but is generally from 8 to 10 days. Over-retting weakens the fibre and destroys its gloss. The fibre must be kept submerged in the water. After retting, the material is thoroughly washed in running water, care being taken to see that it is free from all foreign matter. The fibre is then sun-dried, combed and baled for shipment.

IT is not advisable to grow Roselle continuously on the same land; two or three crops may be harvested, after which a suitable rotation, e.g. Roselle and Groundnuts, should be adopted.

THE yield of combed fibre is about half a ton per crop, per acre; yields have been obtained, however, on one Estate, of 1,400 lbs. per acre.

THE following figures were obtained on an estate in Perak, and are based on Roselle being grown as a catch-crop, with a yield of half a ton per crop, per acre.

Tillage to a depth of six inches, harrowing, sowing and other charges in bringing the crop into bearing ..	$0.65	per lb.
Cutting and Stripping	2.00	„
Retting	2.00	„
Baling	0.10	„
Total cost on Estate exclusive of cartage and freight, etc. ..	$4.75	„

i.e. $106.40 per ton.

THE freight on 1 ton of fibre to London is as follows:—

Rail freight	$11.52
Charges receiving, etc., rail into store ..	3.20
Insurance, premium and stamp (Insured for £35)	1.98
Steamer freight to London and stamp ..	28.00
Charges of receiving, storing, forwarding and shipping	9.60
Bills of lading and stamp	1.50
	$55.80

making an all-in cost c.i.f. London of $162.20 or $81.10 per acre. The above figures presume effective baling at 50 cubic feet per ton, which is the allowance given by shipping companies. The acquisition of a baler is therefore essential for economical marketing.

THERE is a good local market for Roselle ropes, which are generally made by the grower, but only a small amount of this fibre is being exported. When Roselle is better known in the home markets there may be a larger demand for the product.

AS an annual it has possibilities as a catch crop in young rubber clearings. On rubber land of good quality soil and comparatively free from timber, two or more crops might be harvested, but it would be unwise to continue its cultivation after the rubber trees are about two and a half years old. Roselle grows to a height of from eight to twelve feet and should not be planted within a radius of five feet from the young rubber trees. It has also been observed to be attacked and killed by *Fomes lignosus*.

THE plant can be recommended as a minor crop in view of the fact that the fibre can be prepared so easily by hand labour and that machinery is unnecessary. The process of retting and cleaning the fibre could be economically undertaken by any small holder; but small areas would not warrant the introduction of a baling press, which is essential if packing and freight charges are to be reduced to a minimum. This difficulty, however, might be overcome by establishing baling centres. In areas of any size a baling press could be profitably installed.

ALTHOUGH the fibre is a valuable one, there will be difficulties at first in securing a market, particularly in the case of the small holder; but there is little doubt that, when it can be offered in commercial quantities, it will meet with a ready sale in the United Kingdom.

KAPOK.

(*Kabu-Kabu*).

THE cotton tree (*Eriodendron anfractuosum*), known to the Malays as kabu-kabu or ka-kabu, is sufficiently familiar to residents in the Tropics to need little description. The tree is readily recognisable by its tall straight trunk, bearing at intervals horizontal branches, which during the fruiting period are devoid of leaves. The value of the tree and its suitability for Malaya are less well-known facts.

KAPOK is used very extensively as a "filler" for mattresses, pillows and other articles of upholstery; and, on account of its buoyancy, and non-matting qualities, it is superior to almost any other filler. Moreover, if the kapok has become hard with much use, it rapidly regains its excellent properties when exposed to bright sunlight. Kapok has also found extended uses during recent years in life-saving apparatus, life-belts, buoyancy cushions and ocean jackets. Up to the present, kapok has not been found suitable for spinning, owing to its short fibre and extreme brittleness.

KAPOK is found in practically all tropical countries, but until recent years had not been considered a crop suitable for plantation conditions. Java supplies 80 per cent. of the world's demand: the exports from that country in 1921 amounted to

over seventeen and a half thousand metric tons, exported mainly to the United States of America, Holland, Australia and England. Thus in 1921 Java received about one and a half million pounds sterling for kapok supplied to other countries. Other exporting countries are the Philippine Islands, Ceylon, India, and Venezuela. The standard kapok comes from Java and is known as Prime Samarang. The prices vary from 4*d.* per lb. for Indian kapok to 15 pence per pound for that originating from Java. The interesting point in the production of kapok in most countries is that practically in every case the cultivation is in the hands of natives, the foreigner managing the marketing.

A census of the trees in the Federated Malay States and the Straits Settlements has been made, with the result that it is ascertained that, although almost all districts contain trees, the amount of kapok obtained is insufficient to meet the local demand. The exceptions to this were in Lower Perak, Kuala Kangsar and Krian Districts, which together contained about sixty thousand trees. The purchase of kapok by Chinese has yielded such poor returns to the Malay growers that the latter sell but a small proportion of their crop, and much of the kapok is allowed to rot *in situ.*

KAPOK will flourish in a wide range of soils, but those of a light friable nature, allowing easy development of the somewhat sparse root system, are preferable. In this country, the alluvial soils along river banks give the best returns, after which a sandy loam is suitable. In Java, the finest crops are obtained from the well-weathered volcanic soils of Samarang. Whatever be the soil, the drainage should be good, although occasional floods over the

area do not appear adversely to affect the trees. Hill land, or any land very subject to white ants, is less suitable, as white ants are the most serious pest of kapok trees in this country.

THE methods of cultivation of kapok must be judged mainly from general agricultural experience rather than actual knowledge of plantation conditions for this crop; for apart from new plantations in the Philippine Islands, Java, and Siam the crop has not been planted on a large scale.

THE land should be well cultivated, and kapok seed planted, either "seed to stake" or in a nursery. The best planting distance is twenty feet square, which allows just sufficient room for the branches, and space for other cultural operations between the rows. Growth is very rapid, and in the case of plantations planted seed to stake, a selection of the particular seedling to be left at stake must be made at an early stage. In so far as the kapok tree is concerned, no further cultural operations are considered necessary, although it is of advantage to the trees to retain the soil in a state of cultivation. It must be remembered too that when the tree comes into bearing, the ground must be fairly clear to facilitate harvesting operations. Kapok may also be planted from branch or stem cuttings, but this practice carries with it many objections. The trees thus propagated will commence bearing about one season before trees obtained from seed, but such trees are more liable to the attack of white ants, are more likely to fall in high winds owing to the absence of tap-roots, and have a much shorter life than trees obtained from seed.

THE trees commence bearing in about four years from planting, when a small crop of perhaps fifty pods per tree might be expected. Thereafter the increase in crop is very rapid. Fruiting takes place once annually, January—May. At this season the leaves drop off and for three or four months the tree is without foliage and is ripening its fruit. A plantation of about eight years would probably give an average of 400 pods per tree. The life of the tree, planted from seed, may be as much as fifty years. The writer has seen trees of 35 years of age yielding over 1,000 pods per annum, and under plantation conditions such yields should be quite possible in younger plantations.

THE pods should be plucked when ripe, and not allowed to fall when overripe, as is the practice in Java and Malaya. The average composition of the pods is as follows:—

Husk and Placentas	44%
Seeds	35%
Floss	21%

IT is generally estimated that one hundred pods will produce 1 lb. of clean kapok.

KAPOK seed contains over 20 per cent. of oil. Large quantities of seed are exported annually from Java. In 1912, nearly 300,000 piculs of seed were exported from Java, valued at about $600,000. The oil is employed in soap making and as an adulterant of other oils. The cake or meal, after expression of the oil from the seed, is a useful cattle food or fertilizer.

MUCH of the kapok from Java is cleaned or partly cleaned by hand; but in order to obtain first class floss, its subsequent treatment by machinery is

KAPOK TREE (ERIODENDRON ANFRACTUOSUM), IN FULL BEARING.

Moreover, any estate provided with machinery can attach kapok cleaning machinery to their shaft, as the horsepower required is small. The great advantage of kapok cultivation is that the land, in addition to bearing mature kapok trees, can, by reason of the little shade thrown by such trees, be utilized for a wide range of additional crops. In Java, vanila, coffee, cacao are frequently grown in this way. In Perak, limes are frequently so grown with success. The possibility of establishing a rotation of fibre crops under kapok is worthy of consideration. The more fibre crops that can be grown in conjunction with kapok the better, as the balers are more constantly used.

THE quality of fibre from Malayan trees compares very favourably with that produced by Sumatra, and it is probable that with better local methods of cultivation and the introduction of machinery, this country could produce kapok equal to that of Java.

THE Department of Agriculture have extended their enquiry on the cultivation of kapok, machinery, marketing, supply and demand, prices etc., and are in a position to give those interested more detailed information than is possible in this place.

COTTON.

COTTON of long-staple grades is not likely to be over produced in the sub-tropical and tropical countries of the world. Moreover, strenuous efforts, with large financial backing, are now being made by the recently formed Empire Cotton Growing Corporation to extend the culture of cotton in British Colonies and Protectorates, in order that

the cotton spinners of Great Britain may obtain adequate supplies of the raw material for their mills. Production of long-staple cotton is in danger of being restricted below normal requirements on account of the ravages of insect pests; and, further, the quality available for British factories is steadily diminishing owing to the increased consumption of this class of cotton by American manufacturers.

THAT every effort should be made to grow long-staple cotton is emphasized by the fact that high-grade cotton is required by the rubber and motor industries. Next to rubber, long-staple cotton is the most important raw-material used by these industries, and the outlook for the future is unsatisfactory because there is not enough of the best grades produced to meet the demand.

ATTEMPTS to grow cotton in Malaya have been made from time to time; but, hitherto, the results obtained cannot be considered satisfactory from a commercial standpoint, because the yield per unit area was either too low, or the quality produced was too poor.

ABOUT 1914, trials were made with Egyptian, American Upland and Caravonica cottons at the Kuala Lumpur and Batu Tiga Plantations, but the crop records of these experiments are not available. A comparatively good return, however, was reported. In 1921 a plot of Sea Island cotton was grown at the Kuala Kangsar Government Plantation. Owing chiefly to late planting, the yield obtained from it was small, but the Superintendent considers that the prospects of cotton-growing in the district are favourable.

At the Serdang Government Plantation, Egyptian and Sea Island varieties have been planted. Here, also, the results were unsatisfactory, apparently on account of unsuitable soil conditions.

Both at Kuala Kangsar and at Serdang the experience gained of the requirements of the crop is likely to prove valuable in connection with further experiments.

In other parts of the Peninsula, the 'kidney' or 'chain' cotton, (*Gossypium brasiliense*), Caravonica, Egyptian, Assam Indigenous, Garo Hill, Dwarf Patani, and other varieties have been grown on a small scale by planters. With the exception of selected strains of Egyptian and Caravonica cotton, all of these have coarse short staples, and are therefore of low value.

Although the prospects of cultivating the more valuable long-staple cotton in Malaya cannot as yet be estimated, recent trials indicate that a fair measure of success may be anticipated in average seasons. It is true that new problems connected with the crop may have to be solved; but, to date, the difficulties which have been encountered are for the most part those which were anticipated, and can be largely avoided by close attention to the requirements of the plant and the careful control of pests.

The most promising cottons in Malaya are those of Egyptian and Sea Island types. These cottons produce the finest, longest and strongest staples; they command the highest market-prices; and, further, they are derived from the same species, *Gossypium barbadense*.

As the market for the finest Sea Island cotton is very limited, types producing moderately fine grades of this class of cotton should be grown; these, together with selected Egyptian varieties, are required in large quantities in Great Britain. The plants can be grown as annuals—that is, they would occupy the land only for about seven or eight months of each year; this is a great advantage because pests can be better controlled, as will be described later. Again, the danger of natural hybridization and mixing of seed of long and short staple varieties would be avoided. Cotton from mixed, or hybridized, seed is hardly saleable.

It has been shown that long-staple cotton of good average quality can be grown in Malaya, provided that its cultivation and the time of sowing are given adequate attention and that pest control is systematised. The best time for sowing the crop would vary in different parts of the Peninsula, calculations being based on the necessity of rain for germinating the seed and the advantages of dry weather during the picking period. The incidence of pests, more particularly the cotton-stainer, depends somewhat on the presence of other host plants, " Kapok," " Roselle," and " Hibiscus," which would require to be destroyed or the pests found on them controlled in localities likely to be devoted to cotton.

The question of rainfall is not serious, since our rains in the growing season are of the nature of showers, though a certain amount of boll-shedding usually results. The extent of this boll-shedding would differentiate between good, average and bad crops in the same way that rainfall affects rice and

coconut crops. Experiments indicate that light, well-drained loams of average water retaining capacity, well worked up, should give the best results and that steep and stiff land should be avoided. Cultivation must be intensive, as opposed to present extensive methods, and this point would probably decide the success or otherwise of planting cotton.

THE eastern and northern States of the Peninsula offer the best prospects for cotton cultivation on account of their more defined wet and dry seasons and their lighter soils.

Paper.

Paper.

THE problem of discovering and utilizing a new source of raw material for the manufacture of paper has been engaging the attention of those connected with the industry for some years, owing to the increasing inaccessibility and threatened shortage of wood from the forests of the northern temperate zones, which at present constitute one of the principal sources of raw material.

ATTENTION is being directed to the utilization of the vast stores of natural products of the tropical and subtropical regions.

THE present consumption of paper is computed at about twelve million tons per annum, and is increasing at the rate of about 25 per cent. annually. About 80 per cent. of the raw material consists of wood, chiefly spruce.

Raw Materials. Ordinary paper consists essentially of cellulose, which is present to a greater or less extent in all plants, various loading materials, chiefly of mineral origin, and colouring and sizing materials.

IT has been stated that any vegetable substance can be converted into paper. Although this is correct in theory, it is fallacious from a commercial point of view, since the difficulties and costs connected with the preparation of the cellulose precludes the use of all except a limited proportion of such raw materials.

THE raw material for paper making may be regarded as consisting of a cellulose and a non-cellulose portion, while cellulose itself may be regarded as a group of three substances, which may be conveniently described as cellulose, cellular cellulose and hemi-cellulose.

THE non-cellulose constituents of plants are of no value in paper making and must be separated. The

value of the cellulose portion depends on the proportion of fibrous and cellular cellulose, which form the complex web of microscopic strands which, when rolled into a uniform sheet, constitute paper.

MANY plants such as cotton, flax, hemp and jute contain fibrous cellulose in strands of varying length, which find a value in the textile and other industries which renders them too costly as paper making materials.

Wood. The cellulose which constitutes the bulk of paper-making material at present is cellular cellulose derived from various grasses or in the form of ligno-cellulose from wood. Wood constitutes one of the enormous sources of supply which has been developed chiefly for the manufacture of newsprint. Soft woods, which are not so valuable for other purposes, are utilised.

IN tropical countries such as Malaya there are many soft woods available; but the chief drawback to the utilisation of these woods is the mixed character of the forests, which renders selection difficult and costly.

Bamboo. Among the cellular cellulose class of raw materials, considerable attention has been paid for some years to bamboo, especially in India and more recently in other Colonies of the Empire. Raitt, the officer in charge of Paper Pulp Investigations in India, considers the utilisation of bamboo as a permanent solution to the shortage of raw material for paper making. The plant, which is botanically a grass, grows with remarkable rapidity and yields a high percentage of cellulose which can be converted into paper of excellent quality.

MANY varieties of bamboo flourish in Malaya. The accompanying identifications of, and observations on, indigenous bamboos, on which experiments are being carried out, have been made by Gamble, Ridley and Burkill.

Malay Name.	Botanical Name.	Height of mature culm. (feet)	Diameter of mature culm. (inches)	Remarks.
Buloh Plang ..	Schizotachyum chilianthum	70	3½	Fertile.
Buloh Seremai ..	Gigantochloa Kurzii	50	2¾	Sterile.
Buloh Pa-aao ..	Gigantochloa Schortechinii	50	5	Fertile.
Buloh Minyak ..	Bambusa Wrayii (?)	65	3½	Sterile.
Buloh Minyak Aao ..	Bambusa vulgaris	50	3½	Sterile.
Buloh Mata Rusa ..	Gigantochloa ligulate (?)	50	3½	Sterile.
Buloh Semeliang ..	Gigantochloa verticallata (?)	90	3½	Sterile.
Buloh Akar ..	?	80	3¾	Sterile.

Grasses and Straw. Cellular cellulose can also be prepared from various grasses and straw.

IN Malaya the two most promising sources of raw material are the wild ubiquitous grass, lalang (*Imperata arundinacea*), which is a pest on waste and abandoned land, and rice straw.

IN view of the successful utilisation of rice straw in Java, and the satisfactory quality of the paper manufactured therefrom, it is considered that this material offers a promising source of raw material in Malaya. The rice is harvested in the usual manner adopted by Malays and only the stems removed from the harvested heads are utilised.

IF Malaya becomes a fibre producing country, waste fibre material would also be available.

Paper Manufacture. The manufacture of paper may be divided into four stages.

(*a*) Production of the raw, bleached cellulose pulp.

(*b*) The treatment of the pulp by "beating," by which the pulp is reduced to a mass of small fibres which form an intimate mixture or suspension in water.

(*c*) The incorporation of loading, sizing and colouring materials in the beaten, wet pulp.

(*d*) The final conversion into paper on a paper making machine, which includes the removal of the water.

Operation A. In the production of chemical pulp the raw material, after having been suitably crushed or cut, is usually digested for varying periods at suitable temperatures with a solution of caustic soda.

THE period of digestion may extend to six hours or longer, and the temperature of digestion and the strength and amount of soda required will depend on the raw material.

THE correct conditions in respect of digestion period, temperature and strength of digestion liquor must be determined by preliminary investigations on the particular raw material to be employed.

AFTER treatment, the caustic soda liquor is run off and the pulp so obtained is washed thoroughly with water and subsequently bleached by means of a solution of bleaching powder or by chlorine.

THE pulp is "beaten" during the bleaching treatment in order to assist the operation.

IN the treatment of wood, which contains a lignocellulose, the raw material is disintegrated by crushing and grinding in suitable machines and produces with water a product known as mechanical wood pulp which is used in enormous quantities for the production of cheap newsprint, other cheap printing paper, and cardboard.

A product known as sulphite pulp is also prepared by digestion of wood with an alkaline sulphite solution.

Operation B. After bleaching, the clean, partially "beaten" pulp is subjected to further "beating" in a machine known as a Hollander, which consists essentially of a flat-bottomed, elliptically shaped vessel in which a paddle wheel with blunt blades rotates at a high speed. The pulp is made to circulate between the blades of the wheel and the bed plate of the Hollander, and is disintegrated or "beaten" into small fibres. The cellulose

also becomes hydrated during the beating treatment. At this stage the product is known as " half stuff " and can be loaded, coloured and sized by adding suitable materials to the mixture in the Hollander.

Operation C. In practice, operations B and C are combined as described above. The object of the paper maker is to incorporate as completely and homogeneously as possible all the materials in addition to the cellulose, which constitute the type of finished paper required.

Operation D. After the pulp, loading, colouring and sizing materials have been sufficiently " beaten," the very diluted mixture is run over the paper making machine, which receives the diluted wet pulp at one end and turns out a finished sheet of nearly dry paper at the other end.

THIS operation requires considerable skill and experience and varies with the type or quality of paper required, while the production of raw bleached pulp requires considerably less skill.

Possibilities of Paper Pulp Manufacture in Malaya. As already indicated, the three probable sources of raw material in Malaya are (*a*) Soft woods, (*b*) Bamboo, (*c*) Grasses and Straw.

(*a*) *Soft wood.*—Owing to the mixed character of Malayan forests it is considered that wood is not likely to become a source of raw material for paper manufacture in Malaya. If mixed wood were used, each variety would require a different treatment before the pulp could be mixed together.

(*b*) *Bamboo.*—Various species of bamboo grow in considerable areas in Malaya where there is not a profusion of other vegetation. Fresh culms are

continuously formed over a long period, and cropping can probably proceed without intermission until the bamboo flowers, when the clump dies. At present no very definite information is available as to the extent of any particular areas of practically pure bamboo growth, nor the yield per unit area or cost of harvesting, transport, etc.

EXPERIMENTS carried out in the Experimental Paper Factory at the Department of Agriculture, and other experiments carried out on behalf of the Department by the officer in charge of Paper Pulp Investigations at the Forest Research Institute, Dehra Dun, India, have shown that with suitable treatment Malayan bamboos yield a satisfactory percentage of pulp producing paper of good quality.

RAITT recommends a preliminary crushing of the stems, which he considers preferable to cutting or chipping, and which renders the nodes as capable of digestion as the internodes.

IN order to economise in the amount of soda required for digestion and to eliminate the colouring of the pulp produced by the degradation of some of the soluble portion of the raw material when a high proportion of soda is used in the initial stage, Raitt recommends also a fractional digestion of the bamboo.

AN average analysis of bamboo was found by him to give the following results:—

Starch Group	.. ..	12 per cent.
Pectose „	.. ..	20 „
Lignin „	.. ..	15 „
Cellulose „	.. ..	53 „

THE solubility of these is in a descending scale, commencing with the starch group which is the most soluble. The first group is soluble in boiling water, the second (Pectose) in 2 per cent. caustic soda at boiling temperature, the third (Lignin) is separated from cellulose by chlorination, and the fourth (Cellulose) constitutes the insoluble residue. A considerable proportion of the starch group and the Pectose group yields dark brown staining solutions, very gelatinous in the case of the latter, on treatment with soda. These substances are therefore preferably removed before the lignin is attacked, since the " pulp " is not formed until the lignin has been removed.

RAITT reports as follows on one species of bamboo—*Gigantochloa Scortechinii* from Malaya, when treated by the fractional digestion method described, which results both in a reduction in the amount of soda required and in the amount of bleaching material, and yields a pulp which can be bleached economically.

REPORTS received from paper makers in Great Britain have shewn that more drastic treatment is required than that given in the case of the samples prepared in our experimental paper making plant.

THE bamboo will crush well and the nodes are not very large or dense. A sample of the pulp prepared by digestion at 30 lbs. steam pressure with 5 per cent. soda solution, containing a total quantity of Caustic soda equivalent to 25 per cent. on the weight of air-dried bamboo, yielded 65 per cent. of pulp, which could not be bleached with less than 29 per cent. of bleach calculated on the weight of raw material.

THE loss of pulp by oxidation caused by the concentrated bleaching solution was about 16 per cent. This pulp was therefore commercially unbleachable due to inefficient digestion. An analysis of this bamboo compared with a good Indian bamboo is given below:—

	Gigantochloa Scortechinii. (Malayan) per cent.	Bambusa Polymorpha. (Indian) per cent.
Moisture	11.00	11.00
Starch group	9.10	8.06
Pectose „	17.10	17.03
Lignin „	15.30	15.71
Cellulose „	47.50=(53.37 per cent. on dry material).	48.20=(54.16 per cent. on dry material).

THE figures indicate a good type of bamboo with moderate lignification. The combining equivalents of the solubles with soda (NoOH) is about 15.5 per cent. on the weight of the raw material, indicating that in bulk it should digest efficiently with 17 per cent. of soda (NaOH).

MISCROSCOPIC examination of the fibre gave the following results:—

	Gigantochloa Schortechinii.	Bambusa Polymorpha.
Maximum length of ultimate fibre	5.00 mms.	2.88 mms.
Minimum length of ultimate fibre	1.75 „	0.60 „
Average length of ultimate fibre	2.95 „	2.45 „

RAITT states that these figures are remarkable, especially the minimum length and average length, which indicate a very good pulp.

THE following temperatures and times of digestion are recommended as a result of experiment:—

Starch and Pectose solubles (=10 lbs. steam pressure).	2 hours	at 115°C
Lignin solubles (=75 lbs. steam pressure).	1 „	at 160°C
Do. do. (=45 lbs. steam pressure).	2 „	at 145°C
Total	5 hours.	

THE total consumption of soda (NaOH) required is 17 per cent. on the raw material; the yield of pulp 43 per cent.

A brilliant white bleached pulp was prepared from this pulp by a consumption of 9 per cent. of bleaching powder calculated on the original raw material weight; the yield of bleached pulp was 41 per cent.

BY bulk treatment on a commercial scale it is estimated that 41 per cent. of unbleached and 38 per cent. of bleached pulp can be obtained.

THESE results indicate that a suitable pulp can be prepared by efficient digestion.

Economic Production. The following information is required in connection with the utilisation of bamboo:—

(*a*) Areas available in a particular district;
(*b*) Weight of raw material per unit area;
(*c*) Cost of cutting;
(*d*) Cost of transport to factory.

RAITT (in 1921) estimates that bamboo can be delivered at manufacturing sites in Burma at 13/6 to 15/– per ton, equivalent to £1. 11*s*. 3*d*. to £1. 17*s*. 6*d*. per ton of unbleached pulp.

MANUFACTURING charges, inclusive of allowances for depreciation of plant, are estimated at under £10 per ton, so that the cost per ton on board steamer in Burma ports will be under £12 per ton, which is the cost of raw material alone in the case of wood pulp. Freight to Europe is estimated at £4—£5 per ton, or a total cost of £16—£17 for unbleached pulp in Europe. This renders the pulp, which is much superior, equivalent in cost to mechanical wood pulp.

TRANSPORT costs are undoubtedly the most important factor in the manufacture, since six tons of material have to be transported in and out of the factory for every ton of product when coal is available as fuel, and 8½ tons when only wood fuel is available.

ANOTHER important factor is the water supply, since 30,000 to 50,000 gallons of water are required to produce one ton of pulp. The water must be of good quality and free from suspended matter and "soluble iron."

LIMESTONE for the recovery of soda is available, and the only imported material which is necessary is soda.

RAITT also draws attention to the peculiar character of bamboo in respect of its gregarious seeding and death.

MOST bamboos flower in cycles of long period, and each species has its own cycle. It reproduces continuously for twenty to sixty years, produces a large crop of seeds and then dies. The new generation produces diminutive stems; succeeding culms increase in size until, after 4 to 10 years, the culms become of full size and are matured in a few months.

(*c*) *Grass and Straw.*—Investigations on lalang grass have been carried out in Malaya and also, on behalf of Malaya, at the Imperial Institute.

THESE have indicated that a satisfactory pulp can be prepared. It is considered, however, that contiguous lalang areas are not now available in sufficient quantities to render feasible a paper pulp proposition depending only on this raw material. Further information, however, is desirable.

RICE STRAW would appear to be a promising source of raw material, although the quantities available in Malaya are not as large as in Java. An excellent quality of paper can be prepared by digestion with soda and subsequent bleaching.

EXPERIMENTS on this material will be carried out later.

Conclusion. Although bamboos and rice straw both appear to be promising sources of raw material for paper making in Malaya, it is necessary to obtain further information, particularly on the points indicated under "Economic Production" above, before more definite recommendations can be made.

Miscellaneous Crops.

Miscellaneous Crops.

THE crops here described include some which have been cultivated previously in Malaya on a somewhat extensive scale, while others are either only in the experimental stage or have been shown to be somewhat unsuited to local conditions.

AS regards those which were formerly cultivated successfully, such as sugar-cane, coffee, tapioca and gambier, they have been gradually superseded through the introduction of rubber (*Hevea*), which gave at the time much higher returns on the capital invested.

THE vast increase in the demand for rubber, and the fact that the conditions in this country were particularly suited to its cultivation, resulted in this crop being planted on an enormous scale, during which period many old and established crops were eventually replaced.

THE cultivation of those crops which are only carried out on a small or experimental scale, such as cinchona, tea and tobacco, is never likely under present conditions to become extended, owing to competition with other countries, in which these constitute their main crops.

SUGAR-CANE.

(*Saccharum officinarum*).

THE sugar-cane is a tall grass or reed, reaching a height of from eight to twelve feet, and is found cultivated in all tropical countries. The chief countries in which it is grown on a commercial scale are Cuba, India, Java, Fiji, Mauritius, Guiana, Hawaii, Philippines and the West Indies. The cane-sugar of commerce is obtained from the juice of the sugar-cane, although the sugar beet yields a similar product.

History.—It is stated that sugar-cane was cultivated by the Chinese in Province Wellesley long before the colonisation of Penang, and cane-sugar was actually exported from Penang in 1805. Later the Malay Peninsula became one of the foremost sugar producing countries, sugar and coffee being the two principal crops grown on a commercial scale.

THE principal areas under sugar cultivation were in Province Wellesley and Krian, but about 1901 its cultivation was extended to Lower Perak. All these areas were gradually planted with rubber, replacing the sugar-cane, and, except for small areas where it is grown for eating purposes, its cultivation has been abandoned.

Varieties of Sugar-cane.—It is not possible in a brief article to give a description of the large number of existing varieties of sugar-cane, but it might be of interest to point out that some of the canes originally grown in this country, such as the "Selangor" * cane and the "Red Purple" cane of Singapore, formed the stock from which a number of new varieties have been developed. The two common

* Also known as the "Salangore" cane.

varieties formerly cultivated in this country on a commercial scale were the "Red Ribbon" and the "Large Yellow" or "Bourbon" cane.

Soil and Climate.—The plant requires a hot, humid climate, alternating with dry periods, and thrives best on flat land at low elevations, preferably situated on tidal rivers, which facilitate proper drainage and also provide a suitable means of transporting the cane to the factory.

THE most suitable soils are sandy loams, clayey loams and alluvial soils containing a fair proportion of clay. Light sandy soils, heavy clay or peaty land are all unsuitable. Good surface drainage is essential as the plant cannot tolerate a water-logged soil.

SUGAR-CANE is a somewhat heavy feeder, and manuring is necessary after the first or second crop.

Cultivation.—The land should be thoroughly clean and free from weeds, changkolled or forked to a depth of six to seven inches until it is brought into a fine state of tilth, and then made up into ridges four to five feet apart. If conditions are suitable, tractors may be employed in ploughing and harrowing the land previous to planting.

ALTHOUGH any part of the cane containing two or three eyes or buds can be planted, it is the usual practice to plant only the top parts of the cane, which contain less sugar. The tops or cuttings, usually eight to ten inches in length, are placed in furrows at intervals of two to three feet apart. They are planted in pairs a few inches apart in an oblique position, with only a small portion above the soil, which should be firmly pressed down.

In order to avoid replanting, the canes after harvesting may be allowed to ratoon, that is, to grow up from the root-stocks. This method, however, was found to be unsuited to this country and only practised as a last resource when, owing to shortage of time and labour, it was impossible to uproot the old cane and replant in the usual way.

The labour requirements for sugar-cane cultivation are fairly heavy, and it is estimated that at least one unit of Indian labour is required per acre, but this can be reduced considerably by employing mechanical power for cultivation and preparation of the land.

During the first six months after planting the soil is maintained in a friable condition by transferring the soil from the ridges to the furrows in which the cuttings are planted.

Canes grown from cuttings usually take about twelve months to reach maturity, but if a second or ratoon crop is allowed to grow from the old roots it will mature in from nine to twelve months.

It is well-known that some varieties ripen earlier than others, whilst climatic conditions may accelerate or retard the period of growth.

Yields.—Shortly after flowering, when the canes become hardened and ripe, which can be seen from their general appearance, they should be cut as close to the ground as possible, since the sugar content is highest near the base. After cutting, the canes are tied into bundles and transferred to punts, bullock carts or trucks on light rails for transport to the factory.

UNDER favourable conditions, the average weight of cane per acre from plants in this country is twenty five tons, yielding about two and a half tons of raw sugar. A sugar content of twelve per cent. and a recovery of ten per cent. on the weight of cane would be a fair average for the types of cane previously grown in this country, but there is no doubt that by careful selection and breeding it is possible to produce improved strains, as is now the case in other cane-growing countries.

Manufacture.—There are two methods of manufacture, one in which Vacuum Pan sugar is produced and the other in which a product known as Basket sugar is obtained. The former process is elaborate and expensive, whilst the latter is somewhat crude and requires less machinery, with the result that the product is less valuable. In both cases the first operation is to express the juice from the cane; this should be done as quickly as possible after the canes are cut, as the juice is normally acid and fermentation, which lowers the content of sucrose or crystallisable sugar, sets in very quickly.

THE canes are passed longitudinally between heavy crushing rolls, and this either crushes or macerates the cane.

WITH ordinary metal rollers it is possible to extract about eighty-five per cent. of the juice in the cane, but with modern machinery as much as ninety to ninety-five per cent. can be extracted.

THE fibrous material left after the extraction of the juice is known as " Megass " or " Bagasse " and is used as fuel for raising steam for the evaporating pans and for power purposes in the mill.

VACUUM PAN sugar is prepared by subjecting the juice to a series of processes, the main objects of which are the arresting of inversion and fermentation by heating, the counteraction of acidity and the precipitation of various non-sugar and colouring bodies by the addition of lime. The subsequent stages are the concentration of the juice by boiling under reduced pressure in a series of vacuum vessels, granulation in a single vacuum vessel by further evaporation, and the separation of the grains of sugar from the molasses or uncrystallisable sugars in centrifugal machines.

MOLASSES, consisting chiefly of sucrose (crystallisable sugar), glucose (uncrystallisable sugar) and water, is a valuable bye-product from which rum is manufactured. It is now also used as a source of power-alcohol.

IN the manufacture of Basket Sugar, which is now rarely practised, the cane juice is neutralised in the ordinary way and boiled in open tanks or pans to a certain consistency, the scum being removed at intervals as it forms. The thick liquid is then run into shallow wooden trays, stirred and cooled quickly, when the mass will form into grains resembling fine sand. It contains all the impurities present in the juice and yields no bye-products.

THE above is only a very brief and broad outline of the process of manufacture. Modern sugar factory practice is highly organised under scientific control.

General.—When sugar-cane was cultivated in this country, sugar was produced at a profit, even with the local price of Basket Sugar as low as $6.00 to $8.00 per pikul*. This was only possible with the system of indentured labour and the low rates of wages in force at that time.

It is estimated that, under present conditions, the actual cost of production would be about $12.00 per pikul or £25 per ton, which leaves little or no margin of profit.

Providing costs of production could be reduced by cultivating improved strains giving a higher yield, and by the employment of machinery in the cultivation of the land, it should be possible to revive the industry in Malaya.

The production of large quantities of beet sugar in Central Europe, however, will always tend to keep down prices, and this factor should not be overlooked when the cultivation of sugar-cane is under consideration.

With a view to encouraging the cultivation of sugar-cane in Malaya, the Government of the Federated Malay States is prepared to consider applications for land for this purpose on specially favourable terms in respect of rent and export duty on sugar.

The Department of Agriculture has recently made a comprehensive collection of the principal varieties of local sugar-canes, and experiments are now being carried out to ascertain their relative values for cultivation on a commercial scale. Further, it is intended to conduct selection and breeding experi-

* 1 pikul = 133⅓ lbs.

ments with these and other varieties, which may be imported from time to time, with a view to obtaining improved strains which will give higher yields and be more resistant to disease.

TAPIOCA.

(*Manihot utilissima*).

TAPIOCA or cassava, a native plant of Brazil, is cultivated in all tropical countries for its large tuberous roots, which are used either directly as food or for the manufacture of the several forms of tapioca of commerce.

THE following figures show the exports of tapioca from the Federated and Non-Federated Malay States during the year 1921:—

	Federated Malay States.		*Non-Federated Malay States.*	
	Quantity.	Value.	Quantity.	Value.
	Pikuls	$	Pikuls	$
Flake	4,864	22,081	25,239	137,695
Flour	1,135	5,736	23,322	92,618
Pearl	10,615	76,540	170,338	1,026,654
Total	16,614	104,357	218,899	1,256,967

Cultivation.—Tapioca is propagated from stem cuttings, which are planted three feet apart. The cuttings should be five to six inches in length and are planted in a sloping direction. The stems are generally made up into bundles, each containing twenty pieces from four to five feet long, the usual price being fifteen cents per bundle; about twenty of these bundles are required to plant an acre. The

Nipah Palm (Nipah Fruticans)

cost of planting is from $4.50 to $5.00 per acre. Apart from ordinary weeding, little or no subsequent cultivation is required.

THERE are two distinct varieties of tapioca, white and red, but the former takes longer to mature and is very seldom grown, except on a small scale.

Harvesting and Yield.—The first crop is ready for harvesting in fifteen to eighteen months from the date of planting and, under favourable conditions, should yield from one hundred and twenty to one hundred and fifty pikuls of roots per acre. The second crop, which is planted almost immediately after the first crop is removed, usually matures a little earlier, about thirteen to fifteen months after planting, and yields only eighty to one hundred pikuls of roots per acre.

IT is estimated that one hundred pikuls of roots will yield fifteen pikuls of flour, but the percentage of flour decreases if the crop is over-ripe at the time of harvesting. In cases where the supply of mature roots is insufficient to keep the factory working, it is a common practice to harvest roots which are not fully ripe and which would normally be allowed to grow for a further two months. The yield of root in such cases is naturally smaller than when the plant is allowed to reach maturity. About one hundred pikuls per day are required to keep a factory of the usual size in regular work.

Manufacture.—The processes of manufacture of the commercial products are fairly simple. The roots are first passed through a washing machine, very large roots being cut in pieces beforehand. They are then transferred automatically to a hopper leading to the pulping machine which contains

graters revolving at a high speed. The grated pulp is carried away in a stream of water and passed through a sieve, which consists of a hexagonal framework covered with fine silk cloth and mounted on an axle at a slight inclination. The fine starch passes through the material of the sieve with the water and is run into settling tanks, while fibre and other debris are discharged at the lower end of the sieving apparatus. After settling, the clear liquid is run off and fresh water added, the starch being stirred with paddles. This operation is repeated several times, until all foreign matter has been removed, the starch being allowed to settle in the tanks of fresh water. The wet, compact mass of starch is then broken up or rubbed through a coarse sieve, heated in shallow iron pans over open fires for a short time, and then placed on heated tables until thoroughly dry, when it is ready for the market.

THE three common grades of tapioca, which are manufactured locally are (1) flour, (2) flake or granulated, and (3) small and medium pearl, but there is no doubt that a large quantity of fine pearl tapioca finds its way into the local market under the name of sago.

Uses.—The tubers are used as a food by natives, the fresh young root being ground and made into meal or bread as a substitute for rice. The tapioca of commerce obtained from the roots, as described above, is used as a food-stuff and for the production of starch and glucose. It is also used for sizing yarns and fabrics and for the manufacture of dextrin. The roots are also considered to be a possible source of power alcohol.

General.—At present the cultivation and manufacture of tapioca on an estate scale is carried on entirely by Chinese.

THE market value of tapioca has improved recently, the local prices (Oct. 1923) now ruling being:—Small flake $11.75, medium pearl $13.75, and small pearl $14.00 per pikul respectively, which are considered sufficient to give a profitable return.

GAMBIER.

(*Uncaria Gambier*).

GAMBIER is a tanning material obtained from the leaves and twigs of *Uncaria Gambier*, which is a large shrub, indigenous to Malaya.

ITS cultivation in this country has always been in the hands of natives, the Chinese being the principal exporters of this product.

THE following are the exports of gambier from the Federated and Non-Federated Malay States for the year 1921:—

	Federated Malay States.		*Non-Federated Malay States.*	
	Quantity.	Value.	Quantity.	Value.
	Pikuls	$	Pikuls	$
Bales	696	6,388	18,606	160,138
Cube	4,348	46,434	4,881	44,339
Total	5,054	52,822	23,487	204,477

THE principal countries to which it is exported are the United States of America, the United Kingdom and India.

Cultivation.—The plant is propagated from seed which is sown in nurseries. The seed deteriorates rapidly and, in order to ensure good germination, great care must be taken to obtain fresh seed. One pikul of fruits will produce sufficient seedlings to plant one hundred acres. The nursery beds should be shaded and the young plants carefully watered during dry weather. When the seedlings are about three inches high, which is at the age of five to six months, they are ready for transplanting in the field. Transplanting should only be carried out during wet weather, otherwise it will be found difficult to establish the plants. The most suitable distance of planting is 6 ft. x 6 ft., or 1,210 plants per acre. After transplanting, little or no cultivation beyond ordinary surface weeding is required, but careful attention must be given to supplying, and any dead plants should be replaced by fresh seedlings from the nursery.

Harvesting.—The crop, which consists of the leaves and young branches, may be first collected at about fifteen months from the time of planting, and further croppings repeated at intervals of four to six months, according to the condition of the growth; should a period of drought follow the pruning, the plants take much longer to recover than when pruning is followed by rain. The prunings, which are from one to two feet long, should be selected from the side branches and never from the main shoots. The number of shoots cut from each plant varies considerably and only the most vigorous shoots should be selected. Under suitable conditions, cropping may be continued for a period of about ten to twelve years, when the land is allowed to become fallow and to revert to " blukar " or secondary jungle.

Extraction.—The manufacture of gambier is very primitive, the product being obtained by boiling the leaves and shoots in water, and concentrating the extract so produced until it solidifies on cooling and stirring. The boiling process is carried out in large, deep pans over open fires. The solid extract is cut up into small blocks and placed on racks under cover, where it remains for seven to ten days until quite dry. These blocks are then pressed together, packed in grass matting and covered with gunny sacking, each package containing about half a pikul. This is marketed as gambier in bales and does not fetch such a high price as cube gambier. The latter requires more attention in its preparation, is free from foreign matter, of a much better colour and, being cut into cubes an inch square, contains less moisture than the crude product sold in bales.

Yields.—With regular prunings from plants grown on good soil a yield of eight to ten pikuls of dry gambier per acre per annum should be obtained.

THE present prices (Oct. 1923) for gambier are $17.00 per pikul in bales, and $30.00 per pikul for No. 1 cube, unpicked; this leaves a good margin of profit.

Uses.—Gambier is an important tanning material, giving a peculiar gloss to leather, which is not produced by other tanning substances. It is also used extensively as a dye in the silk trade.

LIBERIAN COFFEE.

(*Coffea liberica*).

LIBERIAN COFFEE is a strong growing species indigenous to Tropical West Africa. The tree is distinguished readily by its considerable height (about

25 feet, if left unpruned), its large, thick leaves and comparatively large berries. It is only suited to cultivation at low elevations.

Cultivation.—The plant thrives well on soils fairly rich in humus; peaty land, providing it can be properly drained, is said to give the best returns. The seed should be carefully selected from only perfectly ripe berries and, after depulping, is mixed with dry ashes and spread out to dry in a warm, shady place. The dried seed is then planted about one inch deep at distances of 6 to 9 inches apart in raised nursery beds, which are covered with heavy attap shade. The beds require careful watering during dry weather, and the shade should be removed gradually as the young plants develop. The seedlings may remain in the nursery beds for 3 to 4 months but, providing the shade has been reduced, they may be removed to the field when they have only 2 to 3 pairs of leaves. At this period they stand transplanting better than if allowed to remain longer in the nurseries.

THE distance of planting in the field should be about 15 ft. x 15 ft., or 193 trees per acre. The seedlings should be transplanted in the wet season, the tap-root being cut off with a sharp knife when the young plants are removed from the nursery. The planted areas should be clean weeded.

WHEN the bushes are about 6 to 7 ft. high they should be topped in order to facilitate the collection of the ripe berries. Pruning is done throughout the year, at intervals of about two months. No permanent shade is required.

LIBERIAN coffee has a vigorous constitution and is more or less resistant to leaf-disease.

Harvesting.—The bushes should begin to produce fruit about 3 years from the date of planting, and are considered to be in full bearing after the 5th. or 6th. year. Fruit is borne throughout the year, during which time two heavy crops may be expected, one about May/June and the other about December/January. Only fully ripe berries should be harvested as the pulper cannot deal with unripe fruit.

THE plant required for preparing the crop for market is simple and should consist of a small engine, water pump, pulper, huller, and a fermenting tank.

THE preparation of the coffee is as follows:—The ripe fruits are washed through the pulper, in which the pulp on the fruits is crushed and removed in a stream of water; the residue is then fermented for about two days, when the remains of the pulp can be easily washed off. The pairs of seeds are then dried, when they are termed "parchment." They are then put through a huller to liberate the seeds, which are separated from the broken parchment by winnowing. The seeds or beans are then ready for the market.

ABOUT 10 pikuls of berries produce 1 pikul of coffee.

THE present price (Oct. 1923) of the dried beans in the local market is about $40.00 per pikul.

ROBUSTA COFFEE.

(*Coffea robusta*).

ROBUSTA COFFEE is a species introduced from the Congo, where it was discovered growing wild. This species grows much more rapidly than Liberian, and is different both in habit and appearance. The handsome wavy leaves are a lighter green, thinner

and larger in size, and there are more berries on each cluster. The robusta berries are much smaller, but the beans are almost the same size as the Liberian.

Cultivation.—The plant grows best on a loose clay loam or a red laterite type of soil but, unlike Liberian, it is unsuited to peaty land. The seed is sown in shaded nursery beds at distances of 6 to 10 inches apart, according to the length of time before transplanting. The shade should be removed gradually, so that the plants are fully exposed when they have four pairs of leaves, at which stage they are also ready for planting out.

THE distance of planting may vary on different types of soil, but should not be greater than 10 ft. x 10 ft., which gives 435 plants per acre. After planting, the area should be clean weeded. To induce branching, the plants should be topped when they reach a height of about 6 to 8 feet. The plant requires less pruning than Liberian, but it is commenced at an earlier stage.

ROBUSTA does not appear to be very susceptible to disease, but it is not free from the leaf-disease peculiar to coffee. It is probably more liable than Liberian to attacks of insect pests.

THE plants begin to flower when eight months old, but the early flowers do not always set. Robusta blossoms throughout the year and the berries should therefore be collected once a month. The berries mature within about ten months of flowering, and are ready for picking when the greater number in the cluster become straw-coloured; the whole cluster may be generally gathered at once. A small crop may be collected in the second year, while the

maximum will be obtained in the fourth year, after which the yield remains fairly uniform. The plant continues to yield well for at least 9 to 10 years. The estimated yields per acre from the second to the fifth year are as follows:—

2nd. year	..	1 pikul (133⅓ lbs.)
3rd. „	..	5— 6 „
4th. „	..	12—14 „

THE berry is much smaller than that of Liberian, and the pulper used for the latter is entirely unsuitable; a small Lidgerwood pulper is the most suitable.

AFTER pulping, the beans are fermented for 36 hours, are then well washed, transferred direct to the drying house, and dried as quickly as possible. While in the drying house, the beans should be turned frequently to ensure uniform drying. Coffee so prepared retains its colour and has a good flavour.

APPROXIMATELY 4 pikuls of berries will give 1 pikul of dried beans.

THE present local price (Oct. 1923) of robusta coffee is about $30.00 per pikul.

SAGO PALM.

(*Metroxylon Sagu*).

THE sago palm is a pinnate-leaved palm, 30 to 40 ft. high, with a short cylindrical trunk, from which is obtained the greater part of the sago of commerce. THE palm thrives exceedingly well in Malaya and may be found scattered throughout the country, being most abundant in padi fields and swampy, low-lying lands, particularly in Negri Sembilan,

Malacca, parts of Perak, Johore and Kelantan. It is not, however, cultivated to any extent in this country for its sago, nearly all the sago manufactured in Singapore being prepared from raw sago imported from the surrounding islands.

In addition, the palm is useful on account of the fact that, after it has grown for about 5 or 6 years, the leaves may be cut and used for making "attaps" for roofing purposes. The attap from this palm is far superior in lasting qualities to that obtained from the nipah palm.

Cultivation.—The sago palm grows best on marshy land on which it is almost impossible to grow any other tropical crop with the exception of padi; it will even grow in many places where padi has been tried repeatedly without success.

It may be propagated either from seed or suckers; the latter method, although being both unsatisfactory and costly, is that usually adopted. Suckers are generally expensive to procure, especially if transported long distances; experience shows that, unless they are most carefully removed from the parent tree, which is very seldom done, they will not survive after being planted out.

On the other hand there is a considerable advantage to be gained by propagating seeds in nurseries, and transplanting the seedlings when about 12 to 18 months old; for not only is this method less expensive, but the results generally prove to be far more satisfactory.

Care should be taken in the selection of the seed, as there are two varieties of the palm, "smooth" and "spiny." This leads to a difficulty when growing from seed, as they do not always breed true and

hybrid spiny types may be produced. The difficulty may, however, be overcome by selecting the seedlings before planting out. Suckers of course will always remain true to type. The smooth-stemmed variety is the more prolific.

THE seeds are planted about 1 ft. apart in slightly raised nursery beds and should be ready for planting in the field after 12 to 18 months. The seeds in the husks are planted just below the surface and shaded until the young plants bear three leaves. The area to be planted should be cleared, and holes dug for the seedlings not less than 15 ft. x 15 ft. apart, giving 193 palms to the acre. The roots of the plants should not be disturbed more than necessary when transplanting, all the roots being properly covered during this operation. For one or two years the plants should be circle-weeded, and any " blukar " or undergrowth cleared sufficiently to prevent interference with the growth of the palms. After this period, little attention will be required, any by leaving one sucker to replace each palm cut out, the ground should be continually productive without much, if any, replanting.

AFTER about 9 or 10 years, or when the palms commence to flower, they reach maturity and are then cut down for sago production. About 50 trees per acre will mature about the 9th. year, after which an annual crop of 50 trees per acre may be expected, as those cut down will be replaced by suckers produced from the roots of the original palms.

THE height of a full grown palm is usually 30 to 35 feet, and the girth from 50 to 60 inches. The mature stems are bought by Chinese at from $1.50 to $2.00 each for the manufacture of sago.

Manufacture.—The palm is cut into logs about 3 to 4 ft. long, the bark removed, and the pith split lengthwise into quarters. The pith is then passed through a rasping machine which grinds it to a fine powder. After passing through the rasper, the powder falls into a revolving washing machine which separates any fibrous matter from the sago; the refuse is discharged from the end of the washing machine, whilst the sago passes through the gauze netting with which the washing machine is lined. The sago and water then flow into long narrow troughs about 8 inches wide and 24 to 30 inches deep, arranged in series, an opening being left at the top to allow the water to pass from one trough to another. The sago is deposited gradually in the form of a white powder, the quantity becoming smaller as each trough is passed until the last one is reached, in which there should be no deposit. After drying the powder, in the sun or by artificial means, the sago flour is placed in sacks for shipment. A tree of average size will produce about 2 pikuls of sago flour.

PEARL sago is made by squeezing the damp flour through a cloth into a sieve, perforated with holes of the required size, from which it falls into a shallow iron pan heated over a fire.

Uses.—Sago flour is used principally for size in the manufacture of cotton piece goods, for starch, and in the preparation of chocolate, corn-flour and mustard, while pearl sago is used for making biscuits.

THE local prices (Oct. 1923) now ruling are: Sago flour $5.75 per pikul, and Pearl sago $8.30 per pikul.

CLOVES.

(*Eugenia caryophyllata*).

THE clove tree is a small conical tree, indigenous to a number of islands in the Moluccas. It is generally about 12 to 20 feet tall, but in some places may attain a height of 40 feet. The cloves of commerce are the dried, unopened flower-buds. The tree is cultivated on a large scale in Zanzibar and Pemba, but also in Penang, Amboyna, Sumatra, Ceylon and the West Indies.

Clove Industry in Penang.—The clove plantations in Penang, which were formerly of importance, are now almost entirely in the hands of Chinese and Malays, who have interplanted rubber, coconuts, and other products amongst the clove trees, with the result that the latter have been gradually forced out of cultivation on many of the plantations. This is responsible for the big decline in the local production.

Cultivation.—The clove does not thrive far from the sea, and grows best on sloping situations up to an elevation of 1,500 feet. The most suitable soil is a dark loam overlying a subsoil of clay mixed with gravel.

THE tree is grown usually from seed, but can be propagated by layering. The seeds are sown 4 to 6 inches apart in nursery beds about 5 feet wide, which should be slightly raised and shaded. The beds are watered morning and evening if the soil has become dry but, after the plants are above ground, watering should be less frequent. When the plants are about 6 inches high they should be gradually hardened by partially removing the shading, and left in the beds exposed to the sun

for a month or two before planting. The seedlings are usually kept from 9 to 12 months in the nursery beds; they should be planted in the field at distances of 25 to 30 feet apart. The tap-root should be kept straight when the young seedling is transplanted. If dry weather is experienced after planting, the young plant must be watered until it begins to throw out fresh leaves. It is sometimes considered advisable to grow the cloves at first under light shade trees, which are removed when the plants become slightly larger. Pruning is very seldom practised, but it is often advisable to cut out some of the inner branches, if these are too crowded. Apart from keeping the ground clean-weeded and clearing the trees of parasites and epiphytes, to the attacks of which they are liable, no other treatment is required until the flower-buds begin to appear. Manuring with cow-dung, or mulching with cut grass or lalang, is however very beneficial to the trees in the early stages of growth.

In Penang, the clove tree commences to produce flower-buds in the fourth or fifth year after planting, but it may be considerably later if the soil is inferior. The buds are ready for gathering from November to January. They are at first green, then become yellowish with a pink tint, and finally dull blood-red, when they are fit to gather. When seed is required, the buds are allowed to remain on the trees until fully ripe, which takes a further three months. The buds are usually gathered by hand, a hooked stick being used to pull down the higher branches. Cloves should be picked in the best condition, neither too young nor too old. After collecting, they should be separated from the stalks and leaves, then spread on dry mats in direct sunlight, placing them under

shelter at night to prevent wetting by dew. This operation is repeated for about seven days, or until dry. Drying with artificial heat is often practised with satisfactory results.

Yields.—In this country a single tree will produce about five lbs. of cloves in a season, which, allowing 100 trees per acre, gives a yield of about 500 lbs. of dry cloves per acre. Higher returns up to about ten lbs. per tree can be expected on the best types of land. The best cloves are large and plump, only slightly wrinkled and of a light purplish brown colour with a purplish bloom. If dried too rapidly, they become black.

Clove Oil.—A large quantity of cloves is consumed in the manufacture of clove oil, the inferior qualities being mostly used for this purpose. The ground cloves are distilled in steam to obtain the essential oil, which amounts to from 15 to 18 per cent. Clove oil is rich in eugenol, from which synthetic vanillin, similar to the active principle of vanilla, is produced.

THE flower-stalks, separated from the cloves during drying, are sometimes dried and distilled. They contain about 5 to 6 per cent. of oil and usually fetch from 3*d.* to 6*d.* per lb. for distillation purposes.

Uses.—Cloves are used primarily as a spice, the first grades being in special demand for this purpose. They are also used to a small extent by natives as a masticatory, being mixed with betel-nut and sireh leaf.

CLOVE oil is used principally in perfumery as well as in medicine and microscopy; alcoholic extracts of clove oil are used for flavouring confectionery and liqueurs.

Market Price.—The present price of cloves (Oct. 1923) in Penang is $110.00 per pikul.

THE most recent London market price (Sept. 1923) for Penang cloves is 2*s.* 6*d.* to 3*s.* per lb., and Zanzibar cloves from 1*s.* 2*d.* to 1*s.* 5*d.* per lb. The oil is quoted at about 7*s.* 6*d.* per lb.

General.—The cloves of Penang have always been highly valued, and have maintained their superiority from the commencement of the cultivation in 1798 to the present day, although the exports from this country are now comparatively small.

ZANZIBAR is now the greatest clove producing country, exporting over 9,000 tons annually. The market value of the Zanzibar cloves, however, is less than that of those exported from Penang.

NUTMEGS.

(*Myristica fragrans*).

THE nutmeg is a bushy tree about 30 to 40 feet in height, a native of the Moluccas, and introduced into Penang in 1798. The tree is cultivated for the nutmeg and mace of commerce, the chief countries in which it is grown being Banda, Sumatra, Java, Amboyna, Penang, Celebes, the Moluccas and the West Indies.

Nutmeg Industry in Penang.—The industry in Penang, which is now entirely in the hands of Chinese and Malays, is of considerably less importance than formerly, the plantations both in Penang and Province Wellesley having been gradually replaced by coconuts and, during more recent years, by rubber.

Cultivation.—The nutmeg is usually cultivated on hillsides from about 200 to 1,500 feet, but is rarely found growing at sea-level.

In Penang, in which are produced the finest nutmegs in the world, the trees are grown on the steep, exposed slopes of granite hills, on which the soil consists of yellow loamy clay, characteristic of the laterite formations of the Malay Peninsula. Bare clay slopes or sandy soils are considered unsuitable, whilst wet or low-lying ground is fatal to its growth.

The nutmeg is propagated from seed; only large well-formed seeds should be selected for this purpose. Seeds of irregular shape, or of a pale colour, should be rejected, also those which rattle in the shell on shaking. The seed should be planted as soon as possible after collection, since it loses its vitality quickly.

The seed is planted in well-prepared nursery beds, composed of good soil, at distances of about 12 to 15 inches apart and at a depth of two and a half inches. The beds should be shaded and watered every other day, or more frequently if necessary. The seeds germinate usually in four to six weeks. It is advisable to reduce the shading of the nurseries gradually. The young plants remain in the nurseries till they are from six to nine inches high, or for a period of about six months, after which they are transplanted. Planting in baskets is sometimes practised with good results.

The young seedlings are planted in the field at a distance of twenty-five to thirty feet apart. The holes for planting should be at least three feet wide and three feet deep, and filled with good surface

soil and leaf-mould. The tap-root should be kept straight, the soil in the hole well pressed around the root and filled slightly above the level of the surrounding ground to allow for sinking. In hot and exposed situations the plants require shading until they have become established, but the shade can usually be removed after ten to fourteen days. Although permanent shade in the form of light-foliage trees is considered advantageous to the nutmeg, the trees in this country are frequently grown in the open.

AFTER the plants are established, they require very little attention beyond keeping the ground clear of weeds around the trees. Mulching with cut grass or light manuring with well decomposed cow-dung is very beneficial, particularly on poor soils, since the nutmeg is a heavy feeder.

PRUNING is seldom necessary, but all dead branches and parasitic plants should be removed.

SINCE the nutmeg is unisexual, that is male and female flowers are borne on different trees, the number of male trees should be reduced, if necessary, leaving one male to every ten or twelve female trees. Unfortunately, it is impossible to distinguish between the two until they begin to flower.

Yield.—The trees usually commence to fruit between the fifth and sixth year, but may take even eight or nine years to come into bearing. They attain maximum productivity at fifteen years and fruit well for a further ten to twenty years. Trees which commence to fruit early are invariably very short-lived. The fruit is sometimes allowed to fall, but it is preferable to collect it from the tree, using,

if necessary, a hooked stick to pull down the higher branches. A good worker in the full fruiting season will collect from 1,000 to 1,500 fruits per day.

THE tree fruits throughout the year, but the heaviest crop is obtained usually in July and August. The whole fruit consists of three parts, (1) the husk, (2) the mace and (3) the seed or nutmeg of commerce.

THE yield of nutmegs from individual trees varies considerably, but good trees should average 1,500 to 2,000 fruits a year. A yield of 750 lbs. of nutmegs and 120 lbs. of mace per acre is, however, considered satisfactory under ordinary conditions.

Preparation of Nutmegs and Mace.—A few days after collecting, the fruits burst open and the mace is detached from the seed by opening it from the top and turning it back. The fresh mace is of a brilliant red colour, rather tough and leathery, and possessing a peculiar turpentine odour. After removal the mace is flattened out, either by hand or between boards. It is then placed in the sun for a few hours each day until dry, which takes from ten to fourteen days.

THE husk and mace having been removed, the seed, which is still in the shell, is dried in the sun in the same way as the mace. When the seeds are dry they rattle in the shell on shaking, and are stored in the shells. As soon as sufficient stocks have been obtained, the shell or seed coat is cracked, which is done either by striking one end with a wooden mallet, or more economically by machinery. After the seed is removed from the shell it is very liable to the attacks of insects, especially if stored for any length of time.

NUTMEGS are valued according to size; and, after cracking, they must therefore be graded. The three common grades are those averaging 65, 85 and 110 nuts per lb. respectively. Defective or broken nuts are converted to powdered spice by grinding, and used for seasoning or preparation of nutmeg butter and essential oil of nutmegs.

THE graded nutmegs are packed in cases or casks for export.

THE local price for nutmegs at the present time (Oct. 1923) is $55.00 and $48.00 per pikul for 80's and 110's respectively.

THE latest London quotations for nutmegs are:— 65's at 1*s.* 6*d.* per lb., 80's at 1*s.* 1*d.* and 110's at 10½*d.*, whilst oil of nutmegs is quoted at 4*s.* 6*d.* per lb.

Uses.—The nutmeg contains about 25 per cent. of a fixed fat which constitutes the nutmeg butter of commerce, prepared by crushing the seeds and pressing the heated meal.

THE nutmeg also contains an essential oil, which is obtained by steam distillation of the pulverised nutmegs, the yield being from eight to ten per cent. Mace also yields an essential oil related closely to that of the nutmeg.

BOTH nutmegs and mace are used principally as spice and flavouring agents; nutmeg butter is used medicinally as a basis for ointments, whilst oil of nutmegs or mace is employed in perfumery and for flavouring liqueurs.

PEPPER.

(*Piper nigrum*).

THE true pepper is a perennial creeping vine, indigenous to Ceylon and Southern India. Both the black and white peppers of commerce are obtained from the dried fruit of the same plant.

THE plant is cultivated on a commercial scale in Java, Sumatra, Malabar, Ceylon and the West Indies. It was formerly cultivated on a large scale in Penang, but the industry has now practically died out.

Cultivation.—The pepper vine requires a moist heat with shade, and thrives better on flat land than on the slopes of hills. The most suitable soil for pepper is one rich in humus; with the aid of manures, it has been grown successfully on stiff yellow clay soils in Malaya.

THE vine is propagated from cuttings, selected from the tops of the best yielding vines, care being taken not to obtain cuttings from male vines only. The cuttings, which should be about one foot long, are planted in well-prepared nursery beds and buried six inches in the ground. The beds are shaded and watered carefully when necessary. After about a year, the cuttings should have become established and can then be transplanted.

THE plant requires support, either in the form of hardwood timber or light-foliaged trees. *Erythrina* trees, when grown from cuttings about 3 feet long and 2 inches in diameter, are very suitable as supports, the best kinds being *E. lithosperma* and *E. stricta; Morinda tinctoria* is sometimes used for this purpose. These are planted 7 feet apart and lopped when necessary.

WHEN the vine cuttings are ready for transplanting, they are lifted from the nursery beds and planted a few inches away from the supports, facing east. In this country the Chinese do not utilise living trees to support the vines, but grow them exclusively on stout hardwood posts, about twelve to fourteen feet long and six to seven inches in diameter, which will not be destroyed by white ants or decay during the life of the pepper plant. The posts give practically no shade, and the ground between them is usually covered with cut lalang, to act as a mulch.

AS the vine ascends, it is tied to the post with soft bast or twine and, on reaching the top, is pulled down and wound round the base of the support. The vines are sometimes manured with fish manure at the rate of about ½ lb. per plant.

PERIODICAL pruning is necessary to prevent the plant from growing bushy at the top; by the time it has reached the top of the support, it will have been pruned at least three times.

Yields.—The vines will commence fruiting as early as a year after planting, but no fruits should be allowed to develop until the plant is fully grown, which will be about the third or fourth year after planting, when it will cover the stake completely. There are generally two crops per annum, one in August or September and the other in March or April, but collection often continues throughout the year. The vines are considered to be in full bearing at the sixth or seventh year and, with proper treatment, will continue to yield well for 12 or 15 years.

AFTER the sixth or seventh year, an annual yield of 3 to 3½ lbs. of dry pepper per vine is obtained

which, with 889 vines to the acre, is equivalent to approximately 2,500 to 3,000 lbs. of dry pepper per acre per annum.

Curing.—Black pepper consists of the ground whole, dried berries. When this form of pepper is required, the spikes are gathered when only a few of the fruits are ripe and red, and placed on mats to dry in the sun. The quality of the pepper can be improved considerably by plunging the berries into boiling water for a few minutes immediately before they are spread to dry. This "kills" the green fruit, which would otherwise take some time to wither, and accelerates the drying process. When the pepper is dry it turns black and is then rubbed by hand to separate the stalks, which are removed by winnowing.

WHEN large quantities of berries have to be dried quickly, drying rooms with artificial heat are generally used.

WHITE pepper consists of the ripened berries, deprived of their black covering before grinding. In order to obtain a white pepper of good quality the gathering is delayed until nearly all the berries on the spikes are of a red colour, but since the fruits on the same spike ripen so irregularly this is not always possible.

AFTER gathering, the fruits are detached from the branches by pressing them underfoot. The berries are then put in large bags and placed in running water, where they are allowed to soak for seven to ten days. When the skins are sufficiently loose and soft, the berries are put into tubs, where they are stamped underfoot in a little water and washed

until all the skins, pulp and stalks are removed. The pepper-corns are then removed from the tub and placed on mats to dry in the sun.

THE local prices (Oct. 1923) for pepper are:—Black $15.50 and White (Sarawak) $23.00 per pikul, respectively.

Uses.—The chief use of pepper is as a spice or condiment. It is used also for medicinal purposes.

IPECACUANHA.

(*Psychotria Ipecacuanha*).

THE ipecacuanha plant is a small perennial indigenous to the dense, humid forests of Brazil.

MOST of the ipecacuanha of commerce is derived from Matto Grosso in Brazil. The United Kingdom imports about 50,000 lbs. annually, and the United States of America a similar quantity.

Cultivation.—The plant is propagated readily from root cuttings, which should be taken preferably from mature plants. The cuttings are prepared by slicing the fresh roots with a sharp knife into small pieces about a quarter of an inch in length. These are placed in a horizontal position in boxes of specially prepared soil consisting of a mixture of two-thirds sand and one-third humus. After planting the cuttings, a thin layer of sand is put on the surface and the cuttings are watered carefully. Under such conditions the cuttings will strike in about one month and, at the end of two months, they should be pricked off about four inches apart into other boxes filled with equal parts of sand and jungle

mould. Shade and moisture are essential, and under careful management the rooted cuttings should be ready to plant in permanent beds at the end of six months.

WHEN the young plants are sufficiently large, they should be planted at distances of from twelve to eighteen inches apart in well-prepared beds about five feet wide, the soil having been previously trenched to a depth of at least two feet to allow the roots to penetrate. Raised beds are preferable, and good drainage is essential. After planting in the permanent beds, the surface soil should be kept loose by light forking with small hand forks to a depth of two or three inches, at intervals of about a month. The plants require shade throughout their period of growth, and regular watering during dry weather. Excessive moisture, however, is detrimental and care should be taken to give only the requisite amount.

Yield.—The roots may be harvested at about two to two and a half years from the date of planting in the permanent beds. A healthy plant will yield from six to eight good roots, which, after drying, weigh from one to two ozs. On a large scale the average yield is usually much less, the estimated weight of dried root being about 600 lbs. per acre per annum.

THE roots are prepared for the market by drying them as quickly as possible. The common method employed is sun-drying, the roots being placed under cover at night to avoid damp caused by dew. Drying can be accelerated considerably by using artificial heat, without affecting the quality of the roots.

IPECACUANHA is prepared from the dried roots of the plant which yield only about one per cent. of the drug, consisting of the three alkaloids, emetine, cephaeline and psychotrine.

THE present market price of dried root is 8*s*. per lb.

Uses.—The pure alkaloids and an extract of the roots are used in medicine. The principal alkaloidal constituent, emetine, is used largely as a specific for dysentery.

General.—Although ipecacuanha has been grown successfully in this country, particularly in Selangor and Johore, it should be noted that there is only a limited demand for this drug, and any attempt to cultivate the plant on a large scale would have the effect of reducing its market value considerably. Further, its cultivation requires much labour and supervision and, therefore, the plant is costly to grow on anything approaching a field scale.

TOBACCO.

(*Nicotiana* spp.).

THE tobacco plant is an erect annual, 4 to 7 feet high, with viscid leaves and stems. The varieties now cultivated originated from *Nicotiana Tabacum* and *Nicotiana rustica*, indigenous to South America. The dried, cured leaves constitute the tobacco of commerce. Tobacco is one of the most widely cultivated crops, being grown on a larger or smaller scale in most countries possessing the requisite climatic conditions.

Cultivation.—Tobacco grows best on alluvial or light sandy loams, rich in potash, lime and humus, heavy

clay soils being unsuitable. A hot, humid climate favours its growth, but a dry season is necessary for harvesting.

THE plant is propagated from seed sown in shaded nursery beds. As the seed is minute (an ounce containing about 400,000 seeds), it should be mixed with fine sand or wood ashes, and broadcasted on the surface. The beds after sowing are flattened down with a piece of wood to ensure the soil being pressed around the seeds. The shade is removed gradually and the seedlings are ready to transplant when 4 or 5 leaves are formed, usually from 4 to 6 weeks from time of sowing. They are then planted in rows about 4 feet apart, at a distance of 2 feet apart in the rows. The young plants are lightly shaded and, if the weather is dry, watered for a few days until established, when the shade can be removed. At about 6 weeks from planting the flower-buds begin to appear. These are nipped off and, at the same time, all lateral shoots removed, so as to divert the vigour of the plant to the leaf.

Harvesting.—About 6 weeks later, the plants will be ready for cutting, the mature leaves being a yellowish green, with brown spots on the surface, and the edges and tips curling downwards. The leaves are removed separately as they ripen, from the base of the plant upwards. The cut leaves are then carried to the drying house where they are spread on the floor to wilt, then tied into bundles of 25 to 30, and strung on poles to wither and dry gradually. This operation usually takes about 3 weeks, drying being complete when the mid-rib becomes soft and brown in colour. When sufficiently dry, the leaves are taken down, sorted into hands of about 14 leaves, according to quality, and then

placed in large heaps to ferment. The heaps are heavily weighted and the position of the hands changed about every 2 days. After about 8 to 10 weeks the leaves will be cured and are then graded for the market. Each plant will yield usually from 8 to 10 marketable leaves.

General.—Apart from small areas planted by Asiatics (usually Javanese), little tobacco is grown in Malaya, that produced being generally of poor type, and prepared for smoking without having been fermented previously. The product is rank and strong but meets the requirements of the native consumers.

THE native growers state that they obtain a yield of about 3 pikuls of tobacco per acre, which is sold locally at from $90 to $100 per pikul.

ONE of the advantages of growing tobacco in this country is the import duty, the present rates in force being as follows:—

Cigars and Snuff	..	$ 1.20 per lb.
Cigarettes	..	0.80 „ „
Native and Leaf Tobacco		20.00 „ pikul.
Other Tobacco	..	0.80 „ lb.

THERE are good possibilities of extending the production of a low grade tobacco, but it is doubtful whether the development of this crop on a large scale would be a success.

DERRIS (TUBA).

(*Derris* spp.).

THE Malay "tuba" includes a large number of plants used as fish poisons, not necessarily belonging to the genus *Derris*; two species namely *Derris*

elliptica, Benth. and *D. uliginosa* are known to contain, in their roots and stems, substances toxic to certain insects.

An investigation is being carried out in the Department of Agriculture to ascertain the relative toxicities of the numerous local plants which go under the name of "tuba," and the best methods of preparing suitable insecticides for use against various classes of insect pests. This will be followed by experiments on the most suitable methods of cultivation of those plants showing a high toxicity.

Chinese gardeners, although appreciating the value of *Derris*, grow it on a relatively small scale, mainly for the purpose of providing an insecticide for use in their vegetable gardens. Considerable quantities of the dried roots are used in the manufacture of certain proprietary insecticides; and, judging from enquiries received from England, it would appear that there is a good demand for the dried root.

As a result of these enquiries, a number of estates are becoming interested in its cultivation on a small experimental scale in case the demand increases. The cultivation of the plant presents no difficulties and, as it is amenable to light shade, there is no reason why it should not be grown as a catch-crop amongst young rubber or coconuts.

Cultivation—Derris may be propagated readily by means of stem cuttings, eighteen inches long, planted in sandy soil. If exposed to the full sun, it is advisable to remove the leaves to prevent the stems from dying from excessive transpiration. Under light shade, the cuttings root earlier, often within six weeks from the date of planting.

THE method of cultivation adopted by Chinese market gardeners is to plant long cuttings, which have been twisted into a circle, at distances of about six feet apart, and allow the plants to ramble over the land. During growth, pig manure is applied to the soil. The crop is not harvested at one time, but roots are lifted as required.

AS a sole cultivation, the best results will be obtained by ridging the land. The ridges should be made three feet apart, the soil being worked into a fine tilth during the operation. *Derris* will grow in most soils, but is partial to a clayey loam containing a fair quantity of sand. The cuttings should be placed on the ridges at a distance of three feet apart, giving 4,840 plants to the acre.

THE roots mature according to cultural conditions, the average period of growth being two years. The weight of fresh roots obtained from a single plant varies from one to two pounds according to the distance of planting. The average weight of roots per plant obtained on the Experimental Plantation, Kuala Lumpur, was one pound and a loss of weight of 40 per cent. took place during drying.

THE retail price of the root in the local market at the present time (Oct. 1923) is about 30 cents per kati*, the wholesale price being from $20.00 to $25.00 per pikul.

BETEL NUT.

(*Areca Catechu*).

THE betel or areca nut palm, native to Malaya, is a graceful tree with a straight, unbranched stem reaching 40 to 50 feet in length, and bearing a crown of from six to nine large, spreading, pinnate fronds.

* 1 kati = 1⅓ lbs.

THE betel nut industry is now slowly dying out, owing to the native preference for planting rubber, although there is a fairly large number of betel palms growing in the Muar district in Johore. In a very few cases are the betel nut plantations under the control of the original owners or planters, who were mostly Malays; the common system is to hire them out on contract, usually to Chinese, who collect and sell the fruit.

Cultivation.—Only virgin jungle land is suitable for the cultivation of betel nuts, and it is stated that, if planted on other types of land, the palms make poor growth and yield little fruit. The palms are usually planted about 8 ft. x 8 ft. apart, giving 680 trees to the acre. Very little weeding is done, and there is always a fairly thick undergrowth of lalang and other weeds. The land is never manured or cultivated, in fact the plantation is allowed to look after itself until it reaches maturity. Fortunately, little trouble is experienced with pests and diseases.

THE palm bears flowers and fruit after the fourth or fifth year, and continues to yield for fifteen to twenty years. As each leaf dies and falls off, it discloses a swollen leafy sheath in the axil. This sheath quickly ruptures and sets free the inflorescence, which is composed of a large number of small, pale-yellowish flowers. The fruit ripens within about six months after the first appearance of the inflorescence.

THE young palms bear from two to six bunches of fruit per year, while older palms bear one or two bunches a year and finally do not fruit at all. All

the bunches of fruit do not appear simultaneously, but the young palms may have fruit and inflorescence in different stages at the same time.

THE average number of fruits to a bunch is about two hundred, so that, on the average, a palm produces six hundred fruits (three bunches) per annum, yielding seven and a half katis of dried nuts. The yield of prepared nuts should be fifty one pikuls per acre per annum, on the basis of six hundred and eighty trees per acre.

Preparation.—The fruits, which are collected when ripe, consist of a thick outer husk of coarse fibre enclosing the nut. It is very difficult to separate nut from husk when the fruit is gathered, but, when dry, this can be done quite easily. The natives classify the finished product according to the methods of preparation, which are is follows:—

Pinang blah.—In the preparation of "Pinang blah," the fruits are split in two parts and spread out, split side upwards, in the sun. The nut is removed easily after two or three days. Care must be taken to protect the fruits from rain, otherwise their value will be impaired. The husks are used as fuel by those who prepare "Pinang salai." The nuts are dried thoroughly and placed in sacks for the market. Most of the nuts in the Muar district are prepared in this way.

Pinang mossi.—The fruits are placed in heaps to dry and the heaps are turned occasionally during three months, by which time the husk is easily removed; the nuts are then dried and packed, but are inferior in quality to "Pinang blah."

Pinang salai.—" Pinang salai " is a smoked preparation of betel nut. The fruits are placed on a bamboo grating, supported by mud walls. A fire of old betel nut husks is made under the grating; this smoulders, giving off a large quantity of smoke, which rises through the grating and thoroughly smokes the fruits. After about five days the nuts can be removed from the husks, and are then dried in the sun for a couple of days, when they are ready for sale. These smoked nuts fetch the best price.

Pinang asin.—" Pinang asin " is obtained by placing unripe fruits (green), mixed with salt, in sacks for two or three months; this product is only prepared to a small extent in the Muar district.

Uses.—The betel nut is used extensively in the East as a masticatory, and it has been estimated that one tenth of the whole human race indulge in betel chewing. It is said, by those addicted to the habit, that it strengthens the gums, sweetens the breath and stimulates the digestive organs.

In addition to its use as a masticatory, it is employed as a drug, and as an ingredient of various tooth pastes.

The present local market price (Oct. 1923) is 18 to 20 cents a kati, the export value being about $10 per pikul.

NIPAH.

(*Nipa fruticans*).

The nipah palm is found growing wild on the banks of tidal rivers, and in coastal swamps throughout the Malayan Archipelago, where it attains a height varying between 15 and 30 feet.

NIPAH is a promising source of sugar, alcohol and vinegar, whilst the leaves are very valuable for the production of roofing material, known as "attap."

THE sap is obtained by tapping the stalk of the partially ripe fruit, which varies from 3 to 5 ft. in length. Since the inflorescence of the nipah palm is near the ground, the spathe is conveniently situated for the collection of the sap. Some time after the fruit is formed the stalk is cut across the top just below the fruit, and each day a thin slice of the stalk is removed to keep the wound fresh, thus rendering the flow of sap more or less continuous.

THE nipah palm in Malaya differs from that in the Philippines in respect of the fruiting, which is not definitely seasonal in this country.

UNTIL quite recently, no attempt had been made in this country to exploit nipah, but during the last two years it has received the serious attention of many members of the planting community.

STATISTICS and general information, such as yield of sap and sugar content, are at present being collected by the Department. A preliminary report on the information so far obtained has already been published.

THE volume of sap shows great variation, as much as a gallon per day having been obtained by tapping three spathes on one palm, while others with one spathe have given only a few ounces daily.

THE sugar content of the sap has also been found to vary between wide limits, as much as 23 per cent. being found in some samples, and as little as 8 per cent. in others.

As a general rule, it will be found that the sap has a low percentage of sugar, if obtained from palms yielding a large volume, while that obtained from palms giving a small volume has a high sugar content. The period over which any particular spathe will yield sap varies from two to six months.

It would appear that the most satisfactory way of estimating yields is on the daily sugar content. The mean yield of sugar of a number of palms selected at random has been found to be between 6 and 7 ounces per palm per day. A conservative estimate of the annual yield of sugar per acre, based on a sugar content of 6 ounces per day, with 100 spathes in tapping at any one time*, and 300 tapping days per annum, amounts to nearly 9,000 lbs. of sugar per acre per annum. This is equivalent theoretically to a yield of absolute alcohol of over 1,100 gallons per acre per annum.

At present, nearly all nipah in this country is in the wild state, little having been planted systematically. Systematic planting has been effected only by natives, by whom the palm is used for making attaps.

The work so far carried out, and the results obtained in this country, are based on observations of nipah palms growing in "kampong" or small-holdings; it is possible that, when the palms are growing in the conditions of a plantation, various factors will modify considerably the yields of sugar produced.

* It is assumed that about 200-300 palms per acre is the correct number, so that the above estimate is based on only one spathe on every other palm being in tapping at any time; whereas it is an established fact that a palm may have three spathes in tapping at any one time, whilst some have been found with as many as ten fruit-heads at one time.

CINCHONA.

(*Cinchona* spp.).

CINCHONA is obtained from the bark of several species of *Cinchona*, which are medium sized trees, 25 to 40 ft. high, indigenous to South America.

THE two species most commonly cultivated are *Cinchona Ledgeriana* (Ledger's bark) and *C. succirubra* (Red bark). The former is much richer in quinine than the latter, and is the species chiefly grown in Java, which is now the biggest quinine producing country in the world.

CINCHONA thrives best at an elevation of 2,000 to 5,000 ft. and requires a rich loamy soil, preferably of volcanic origin.

THE plant is propagated from seed, which is sown in specially prepared seed beds, the seedlings being transplanted later to distances of about 3 to 4 ft. apart. Where virgin land is available, it is generally planted with *Ledgeriana* seedlings, but land on which this variety has been cultivated previously is usually replanted with grafted stocks of *Succirubra-Ledgeriana*, that is *Ledgeriana* grafts on *Succirubra*.

FROM the third or fourth year after planting, cropping by selective thinning and pruning is carried out throughout the year, and is continued for a period of 15 to 25 years according to the nature of the soil. The percentage of quinine in the bark is at its maximum about the eighth year after planting.

WHEN ready for cropping, the trees are lifted with the roots intact, since both the root and stem bark are rich in alkaloids. The bark is removed and dried in artificially heated drying rooms at a temperature of about 80° C., the resulting product being used for the manufacture of quinine.

It is estimated that about 600 lbs. of dried bark per acre per annum can be obtained on good cinchona plantations in Java. The average quantity of alkaloids in the dried bark is usually about 6 to 7 per cent.

Quinine is used only for medicinal purposes, principally in the treatment of malarial fever.

So far this crop has only been grown experimentally in this country.

VANILLA.

(*Vanilla planifolia*).

Vanilla is the product of a large climbing orchid, indigenous to Central America, but now distributed widely throughout the tropics.

The vanilla of commerce is obtained from the cured pods.

The plant is propagated from cuttings, which are first struck in the nursery and later transplanted into the field. Owing to its climbing habit, it requires support in the form of a hardwood trellis or a shade tree of light foliage, such as the " dadap " (*Erythrina* spp.).

Flowering should commence in the third year, the flowers requiring artificial pollination. The pods begin to ripen about 4 to 5 months after pollination, and should be gathered immediately they show signs of turning yellow. A vine should not be allowed to bear more than 25 to 30 pods.

The drying and curing of the pods after gathering is an important operation. This consists in dipping them into boiling water for a few seconds, then

drying in the sun, after which they are fermented in blankets, the drying and sweating process being continued until the pods become quite brown. They are then stored for a month before packing.

THE cropping of vanilla is very irregular, causing considerable fluctuations in the market price.

VANILLA is used as a flavouring agent, chiefly for confectionery and liqueurs.

THE cultivation of vanilla has been attempted in this country; but, since the period of ripening coincides with the wet season, it is not altogether a success, the pods being apt to fall before they are ripe and are thus spoilt.

CINNAMON.

(*Cinnamomum zeylanicum*).

THE true cinnamon is a medium sized tree, native to Ceylon and Southern India, 20 to 40 ft. high, but in cultivation is grown as a coppiced bush. The dried bark furnishes the cinnamon of commerce.

THE tree is usually grown from seed sown in nursery beds in clumps of about 25 seeds, the clumps being placed about 6 inches apart. After about one year these clumps are transplanted into the field to distances of 6 feet apart. Little cultivation is necessary beyond keeping down high weeds and particularly climbing plants.

THE shoots are ready for harvesting in the 3rd. or 4th. year, and cutting takes place twice a year during the rainy seasons. Shoots selected for cutting are usually of two years' growth. These are cut, the

tops and branches removed, leaving sticks from 3 to 4 ft. long. The bark is then peeled off, collected in bundles, pressed and bound together. It is then covered with matting and allowed to ferment slightly, in order to facilitate the removal of the cuticle. The pieces of bark are then sorted and dried, being packed together one inside the other to form pipes. These pipes are then further dried in the sun and graded for export.

THE dried bark is used mainly as a spice, but is also utilised for medicinal purposes and in the manufacture of incense.

So far, cinnamon has only been grown on a small experimental scale in Malaya.

COCAINE.

(*Erythroxylon Coca*).

THE coca or cocaine plant is a small bushy shrub, 6 to 8 ft. high, indigenous to Peru and Bolivia, where it grows wild at elevations of 4,000 to 6,000 feet. The drug cocaine is extracted from the dried leaves.

THE plant is easy to cultivate and grows very rapidly from seed. The seed is sown in nursery beds, the seedlings being transferred after 7 to 9 months to the field, and planted at distances of 4 to 6 feet apart.

THE first picking of leaves can be made at about 1½ to 2 years from the date of planting, after which several pluckings of leaves can be made each year. Only mature leaves which have the highest alkaloidal content should be picked. The leaves are

dried, in the shade or by artificial heat, to retain as far as possible their light green colour. The dried leaves should be packed for export in airtight cases to keep out moisture and to prevent fermentation.

It is estimated that, under good conditions, a yield of about 1,500 lbs. of dried leaf per acre per annum can be obtained.

The drug cocaine is used in medicine, chiefly as a local anaesthetic. The plant is not grown in this country to any extent, its cultivation being allowed only under licence.

TEA.

(*Camellia Thea*).

The tea plant, indigenous to China, Japan and India, varies in height according to the variety, some of which, if left unpruned, may attain a height of from 30 to 40 feet. In cultivation, however, the plants are topped and kept as bushes. The dried leaf provides the tea of commerce.

Tea is propagated from seed, which is sown in shaded nursery beds. After about 10 months the seedlings are ready for planting in the field. The distance of planting is from 4 to 5 ft. apart and the plants are topped about 18 months after transplanting.

The first picking of leaf commences in the third or fourth year, according to elevation, subsequent plucking taking place every 10 days. When the bushes cease to flush they are pruned back severely,

this being necessary at intervals of 15 to 18 months at low elevations, and 3 to 4 years at high elevations. The plants are in full bearing when about 6 years old, and continue to yield for many years.

PLUCKING consists in nipping off by hand the tender terminal leaves with the bud and the shoot. The pluckings are brought into the factory where they are withered, dried, rolled, and finally sifted into various grades for export.

OWING partly to lack of suitable land at the necessary elevations, the cultivation of tea has not been developed in this country. Small isolated areas are, however, to be found, the product being consumed by the native population.

GUTTA PERCHA.

(*Palaquium* spp.).

GUTTA PERCHA, which is used principally for the protection and insulation of deep sea cables and also extensively in the electrical industries on account of its high insulating properties, is obtained from several East Indian trees of which *Palaquium oblongifolium* or *Palaquium Gutta*, known to Malays as "taban merah," and *Palaquium obovatum* and other species, known as "taban puteh," are the most important. The gutta from the former is of superior quality to that obtained from the latter.

TABAN MERAH is indigenous to Malaya, Sumatra and Borneo and has also been introduced into Java, where several thousand acres have been planted by the Dutch Government at an elevation of about 2,000

feet. The trees are present in varying numbers in the forest reserves and jungle in many parts of the Federated Malay States.

THE supplies of the indigenous product are controlled by the Forest Department and the systematic improvement of the forest reserves in areas where the trees are found in large numbers constitutes an important branch of the work of that Department.

GUTTA PERCHA was first cultivated under plantation conditions in Java and more recently an area of several thousand acres has been acquired in Malaya by a British Company for a similar purpose and over one thousand acres have already been planted out, while large nurseries exist for further planting. Under these conditions the plants are being cultivated as low-growing bushes for the production of leaf from which the gutta is extracted mechanically. This cultivation may therefore reasonably be considered an agricultural industry.

Cultivation. Although it is possible that ideal methods of planting the seed and of transplanting the seedlings in the field have not yet been attained, a number of factors essential to success are known.

THE principal difficulty at the present time is a sufficient supply of seed. Further, the seed deteriorates rapidly and loses its germinating power in a few weeks. Seed in the jungle from the indigenous trees is also liable to attack by insects and other pests, so that a considerable loss of the total available seed occurs.

THE fresh seed may be sown in nurseries or germinated in moist sawdust, and subsequently planted in the field.

THE latter system is fairly satisfactory under suitable weather conditions. The germination from good seed is excellent. If seed is planted at stake, two seeds should be sown per hole and protected with a lalang (grass) cap.

IN Malaya, the seedlings are planted 6 feet by 5 feet in the field, while in Java the distance is 4 feet by 4 feet. If the growth is good, somewhat wider planting would appear to be preferable. The planting of seed in baskets in the nurseries and the transplantation of the seedlings (in the baskets) in the field should give excellent results, although the cost of baskets would amount to about fifteen dollars per acre.

SEEDLINGS may be planted out when four to eight months old and should be shaded in the field until established. If they are allowed to remain longer in the nurseries, they may be "lifted" during suitable wet weather and planted as stumps. In order to encourage lateral branching and to prevent the plants from becoming too tall, they are topped at about 6 feet and branch pruning is adopted. This encourages a bushy habit which produces a good supply of leaf.

Methods of Extraction.

(*a*) *Tapping.*—The present practice in the case of large indigenous trees is to tap the trunk by making a large number of herring bone cuts or incisions on a considerable length of the stem or trunk. Unlike the Para rubber tree, gutta percha trees can only be tapped at long intervals and, owing to the fact that the latex is distributed irregularly and in pockets, a large number of cuts is essential, since each cut may only drain a small lactiferous area. Ladders

and other methods of climbing the trees for tapping purposes are employed and the tapper is only able to tap a few trees per day. The latex coagulates very rapidly on the cuts and is removed chiefly in the form of coagulum.

In the past, the trees were felled and incisions made all over the trunk of the felled tree. This has resulted in practically complete extinction of the trees in Sumatra, but fortunately in Malaya these methods have been prohibited in time.

The gutta is cleaned by treatment in hot water, in which it readily softens and can be rolled or pressed out into thin sheets by treading under foot or by better methods. While still hot the products can be pressed into suitable blocks which, on cooling, become quite hard and can be exported in this form. Adulteration is easy and control is therefore essential.

(*b*) *Extraction from Leaves.*—The cultivation of trees for the extraction of gutta from the leaf appears, however, to be a more promising method for plantation conditions. The gutta is extracted from the leaf and young twigs mechanically by grinding the leaf very finely in special types of mills (edge-runners similar to those employed sometimes for seed crushing in oil mills), heating the ground material to a suitable temperature (about 70°C) for a suitable period in hot water with constant stirring, and subsequently transferring the hot mass into a large volume of cold water.

The gutta floats to the surface and can be skimmed off while the remainder of the leaf material sinks.

THE material which sinks still retains a certain amount of gutta and requires retreatment in a similar manner. The gutta, which is in a fairly fine form, is warmed again in hot water and cleaned in a Universal Washer or other suitable machine. After cleaning, it is again warmed and then pressed into blocks while still hot, for export.

IT is of interest to state that the grinding is an important operation. It has been found from experiments carried out in the laboratories of the Department of Agriculture that, although efficient grinding can be effected on an ordinary rubber crepeing machine, it is impossible to separate the gutta from the ground mass, possibly owing to the fine state of division and disintegration.

FRESH leaves should be employed; the leaves should be ground not later than the day after collection, otherwise a loss of gutta occurs and the product is also inferior in colour.

IN practice the yield of gutta is about 2.3 per cent., calculated on the fresh leaves, although it is understood that higher yields can be obtained by improved methods of extraction. It is estimated that the first plucking of plants in the 3rd or 4th year will yield about 3,000 lbs. of leaf per acre per annum, increasing to a maximum of 10,000 lbs. per acre per annum.

ALTHOUGH the cultivation of gutta percha is somewhat intricate and costly it would appear that, at present market values, the cultivation should yield a profitable return. The demand at present exceeds the supply.

THE current market quotations in Singapore (October, 1923) are as follows:—

Fine Red	..	$300.00 per picul.
Lower qualities	..	$150.00 „

A high-grade product prepared by the Forest Department from tapped trees will probably realise more. Leaf gutta, owing to the presence of more impurities, in the form of vegetable debris, will fetch a lower price than that prepared by tapping, since the presence of foreign matter affects its insulating properties.

Plant Diseases & Pests.

Plant Diseases & Pests.

THE following account deals with the problems of diseases and pests of economic plants in Malaya under three headings:—Fungoid and Bacterial Diseases, Insect Pests and Methods of Inspection and Control.

FUNGOID AND BACTERIAL DISEASES.

THE study of fungoid and bacterial diseases in their true relation to extensive cultivation is of comparatively recent date, and it is only during the last two decades that the losses accruing to cultivators have been realised and approximately estimated. The extent of the losses caused by crop diseases is illustrated by the following figures given by various authorities in America.

(1)	California Vine Disease in 1892	G. $10,000,000
(2)	Wheat Rust in United States 1898 ..	67,000,000
(3)	Wheat Rust in Illinois in 1885	1,875,000
(4)	Potato Late Blight in New York 1904 ..	10,000,000
(5)	Potato Blight in United States (annual) ..	36,000,000

Plantation Conditions in Relation to Rapid Spread of Diseases. Before proceeding to deal with specific crop diseases of local interest, it may be instructive to indicate the chief reason why plant diseases become more dangerous when a jungle tree, such as the rubber tree, is cultivated under plantation conditions. In the natural forests every tree is a survivor in the struggle for existence and only the hardiest individuals come to maturity. In the jungle, the mature trees or groups of trees of any single species are usually separated from the individuals of the same species by trees of widely differing constitution. Specialization or preference for one individual host, or at most a narrow range of hosts, is a well-known phenomenon in the case of parasitic fungi, so that, under jungle conditions, a diseased tree may be found, but the fungus causing it cannot attack the neighbouring trees because their constitution is so widely different from that of the attacked tree. Plantation conditions are diametrically opposed to those of the jungle—the struggle for existence does not operate to the same extent, since each seedling plant has similar conditions and many comparatively weak individuals survive. The weak individuals may be attacked more easily by disease, and since each tree has a similar constitution to its neighbour, every single tree in the plantation may become infected. Plantation conditions, as a rule, favour rapid spread of disease and it is easy to realise that the greatest care is necessary in the case of the cultivation of a jungle plant taken from its native habitat.

Diseases of Rubber.

PRIOR to 1912 little definite research work had been carried out on the diseases of the rubber tree.

During the last decade, however, many investigators have been engaged on disease problems wherever *Hevea brasiliensis* has been established on a large scale, so that our knowledge of the more important aspects of rubber diseases is now fairly extensive. It is important to mention here that information obtained in respect of diseases in one country does not necessarily apply, without modification, to other countries. Growth conditions in different countries may vary enormously, and this may influence the conclusions to be drawn from any research to such an extent that any recommendations may apply only in the country concerned. Any conclusions stated in this article must, therefore, be regarded as not necessarily applicable to countries other than Malaya.

Rubber diseases in Malaya can be classified as:—

(*a*) root diseases.
(*b*) stem and branch diseases.
(*c*) bark diseases.

THE above divisions are self-explanatory with the exception of (*c*). Bark diseases are so called because they occur when the tree is tapped for the extraction of latex. The latex flows from the cortical tissues when a thin paring of cortex is excised by the tapping knife. The tapping is done at regular intervals, usually once per day or once every two days, and each tapping exposes a thin strip of tender tissue and forms a suitable place of entry for certain fungi. Bark diseases are, therefore, diseases of the tapped surface.

Root Diseases. In dealing with root diseases, reference must be made to the method of opening up the land previous to planting. Most Malayan plantations are started on virgin jungle

land. The jungle trees are felled, leaving the stumps in the ground, and the luxuriant undergrowth is cut down. After a period of dry weather the timber and dried undergrowth over the felled area are fired. After the fire, the stumps and large logs, though much charred, still remain and during decay form suitable food material for fungi. The original source of the root diseases of *Hevea brasiliensis* can be traced to the jungle stumps and logs left on and in the ground. If the land were cleared thoroughly before planting it could be stated definitely that root diseases would be negligible on Malayan rubber plantations.

THE following root diseases have been investigated in Malaya:—

Fomes lignosus (*semitostus*).

THIS fungus causes most damage on young plantations with trees under seven years of age. Occasionally in localised areas it has caused considerable devastation. Most plantations have suffered loss from this disease; but since, owing to close planting, the trees have to be thinned out at the age of six or seven years, the loss caused by this disease has not, in the past, had serious consequences.

THE distinguishing characteristic of this fungus is the white external rhizomorphic strands running over the lateral roots of the tree. The fruit-bodies are remarkable in being persistently sterile, while similar fruit-bodies of closely allied species produce millions of spores, each capable of infecting a healthy tree under suitable conditions.

Sphaerostilbe repens.

THIS fungus causes a root disease of rubber trees, of any age, growing in acid, water-logged soil, and

is most common in the coastal areas. Occasionally this fungus destroys large areas of rubber but usually its action is slow and only individual trees are attacked.

THE more characteristic features are the flat, black, interweaving rhizomorphic strands, seen closely adpressed to the wood when the bark is removed from the diseased roots, and the fruits of the fungus which, when present, are typical though rather minute. The soil round the roots of an attacked tree and the diseased wood as a rule give off a most unpleasant odour when freshly dug up.

Ustulina zonata.

THIS fungus disease is wide-spread, and numerous cases can be found in many old plantations. The fungus is capable of attacking any part of the tree, i.e. root, stem or branch, if the wood is exposed. It often works in conjunction with boring beetles; the insects, after penetrating the wood, are followed by the fungus, and, in such cases, the trees are killed very rapidly. The fungus often enters the stem at places where large branches are broken off by the wind or other agencies.

IN all cases in which *Ustulina zonata* is active in tissues of *Hevea brasiliensis*, the appearance is the same,—a typical dry rot of the woody tissues with numerous conspicuous black lines, running through the rotted wood. The disease is most common on trees over eight years of age.

Fomes pseudo-ferreus (Wet-Root Rot).

THE action of this fungus on roots of *Hevea brasiliensis* is very distinct from that of *Ustulina zonata*. *Fomes pseudo-ferreus* produces a typical "wet-rot," in whatever situation the attacked tree

is growing. The disease is very dangerous on account of its subterranean habit, for an attacked tree usually blows over before the disease appears above soil level. When a tree is found attacked by this fungus it may be assumed that a number of neighbouring trees are also affected. This disease has caused large losses on many of the older plantations, but is seldom found on young trees.

THE wet-rot of the freshly-dug roots together with the inconspicuous brownish lines in the attacked tissue serve to diagnose the attacks of this fungus.

Brown Root disease.

THIS is not a common disease on rubber but the appearance of attacked roots is quite typical. The mycelium of the fungus binds up earth and stones in the immediate proximity of the roots to form a firm encrusting mass, which is detached with difficulty. The Brown Root disease is a common feature in other tropical cultivations, *e.g.* tea, coffee, camphor, which will show similar symptoms. This disease is under investigation at the present time, but little definite information has been obtained.

IN these diseases, control measures take the form of preventing the spread of the disease by trenching round the affected areas, removing and burning dead wood, and applying lime before supplying.

Stem and Branch Diseases. Only two stem and branch diseases require to be mentioned, viz. Pink disease and Die-back disease.

Pink Disease.

THIS disease is caused by a fungus known as *Corticium salmonicolor*, which on *Hevea brasiliensis* shows varied manifestations. Prior to 1912 the

disease was common in only three small centres but in 1913-14, it assumed epidemic form, and spread rapidly, practically throughout the whole Peninsula.

THE name, Pink Disease, is associated with the commonest appearance, a continuous pink incrustation covering the attacked branches. The other manifestation, which calls for most attention, is the "Necator" stage which occurs in the form of a series of orange red pustules. These are made up of cells which vary much in size; under suitable conditions the component cells break apart and are blown about as single-celled spores. The "Necator" was originally believed to be a fungus different from *decretus*. During wet weather Pink Disease becomes very active, and it may be necessary to increase the number of coolies in the "Pest gang" in order to control the disease. Painting the affected branches with tar, or with a mixture of tar and crude oil, is an effective control, if the disease is taken in hand

at an early stage.
that causing Pink disease, and was named *Necator Diplodia cacaoicola*.

"DIE-BACK DISEASE." The fungus, *Diplodia cacaoicola* is a wound parasite which can enter through the smallest wounds, and is a common disease in all plantations, more especially when growth conditions are adverse. After this fungus has entered the tissues, it passes up and down the water-conducting vessels very rapidly, and prevents the upward passage of water to the leaves, which wilt and die. The threads of the fungus, dark in colour, cause a pronounced ashy-grey discoloration in attacked wood, which is very characteristic. A noticeable feature, at times, is the association of

this fungus with lightning; a group of trees is scorched by lightning and *Diplodia* enters the scorched tissues to grow very rapidly, so that in a few days a group of dead, leafless trees is found.

Bark Diseases. Before 1916 Malayan rubber plantations had not suffered seriously from bark diseases, though plantations in Java and Ceylon had been severely affected for many years. The most prevalent disease, previous to 1916, was " Black Stripe " disease, the fungus held responsible being a species of *Phytophthora*.

Black Stripe.

THIS disease assumed epidemic proportions in certain districts in Malaya in 1916. A *Phytophthora* was isolated and shown to be the cause of the disease. Weather conditions play a large part in determining the appearance of Black Stripe epidemics, continued damp and misty mornings being exceptionally favourable to the fungus. A dry weather period assists in bringing the disease under control.

" Mouldy Rot."

THIS disease, caused by the fungus *Sphaeronema fimbriatum*, is a serious disease of the tapped bark of rubber trees in Malaya. It has recently been reported from Java, associated with outbreaks of Black Stripe disease. Until two years ago the disease was very localised, but recently there has been a serious extension of the area affected by the fungus. This disease is not easy to control, but the damage to the tapped surface can be avoided at a reasonably low cost if control measures are correctly applied. These take the form of painting the affected surfaces with disinfectants at definite intervals.

Brown Bast.

THIS bark affection has attained considerable prominence during the last few years, one of the most interesting features to the layman being that no investigator has yet succeeded in establishing a definite organic cause, i.e. fungus or bacterium. The generally accepted opinion is that no parasitic organism is concerned, but that the affection represents a morbid physiological condition which is influenced by excessive tapping. The symptoms are difficult to describe briefly, but the ultimate result of a Brown Bast attack is the cessation of latex flow from the tapping cut. All dry trees must be suspected, but it may be pointed out that trees often cease to yield latex from causes other than Brown Bast. Numerous experiments are in progress in most rubber growing countries to determine the factors influencing the development of this bark affection.

Spotting of Prepared Rubber.

DURING the years 1911-1913 planters experienced much trouble owing to coloured "spots" and "flushes" appearing in their rubber, particularly pale crepe rubber, in the drying sheds. These discolorations have been proved to be due to minute fungi and bacteria, which, growing in the moist rubber, produce red, yellow or violet pigments. These fungoid and bacterial discolorations still appear sporadically, but outbreaks are now usually controlled fairly easily, since it is known that the "disease" is invariably due to bad conditions in the drying rooms. Rubber however frequently becomes spotted, due to damp conditions, after it has been despatched from the estate.

Diseases of Coconut Palms.

In Malaya, coconut palm diseases have not hitherto called for much attention. The general situation in respect of coconut plantations is the opposite to that of rubber. The coconut palm is indigenous to Malaya or was introduced naturally, and grows crowded together along river banks owing to the fruits being suitable for water dispersal, and plantation conditions more or less simulate those obtaining in nature. It is therefore probable that no physiological strain is imposed under plantation conditions, and the trees have every chance of developing along the proper lines.

A few diseases of coconuts, the most important of which is Bud-Rot, require mention.

Bud-Rot.

"Bud-Rot" is a general term and the disease has been recorded on most palms, e.g. areca palm, African oil palm and palmyra palm. The mature leaves of palms surround the growing point, forming a very substantial protective sheath. The growing point, from which the newly developing leaves arise, is part of a large mass of spongy tissue, very rich in food materials, known as the cabbage or bud. If this bud is injured in any way, and micro-organisms effect an entry, a rapid rot is caused and the firm bud tissues disintegrate to a soft, pulpy, evil-smelling mass, the growing point being involved in the general destruction. The evil odour indicates the rapid putrefaction which is being caused by different kinds of fungi and bacteria. When the tissue of the growing point is wholly destroyed, no further growth can take place and the palm dies.

BUD-ROT is an epidemic disease in the Philippines and the West Indies, but no epidemic has been reported in Malaya. The cause of Bud-Rot in the Philippines is said to be the fungus *Phytophthora faberi:* in India and the West Indies, *Phytophthora palmivora.* Observations in Malaya suggest that more investigation is necessary before a definite cause can be assigned. Inoculations on oil palms and coconut palms with both the above mentioned species of *Phytophthora* have, so far, proved unsuccessful in Malaya.

Pestalozzia palmarum.

THIS fungus is present wherever coconut palms are grown in Malaya. Healthy palms suffer little damage although the fungus may be growing on the leaves, but if the palms are growing under adverse conditions a serious set-back is often caused. Large portions of the leaf tissue are killed and the fruit-bodies of the fungus appear as minute, black elevations about the size of a pin's head, in the dead leaf tissue. The fungus also attacks the African oil palm.

Helminthosporium incurvatum.

THE fungus—*Helminthosporium incurvatum* is not commonly found attacking palms in Malaya, but on two occasions has caused some trouble. The attacked palm-leaves generally present a scorched appearance and, if the blackened portions are carefully scraped, the hyphae and typical spores of the fungus are found. This fungus has also been observed on African oil palms.

MANY other interesting diseases of coconut palms have been noted but not investigated. The above mentioned diseases of the coconut palm are often found attacking the African oil palm. A peculiar

disease also found on young African oil palms has been noted, the cause of which is obscure. In the early stages, from the first to the third year, the third leaf from the centre collapses at the base. This is followed gradually by the collapse of the outer leaves, so that finally only a single central leaf may be standing rigid. The youngest central leaves are left uninjured, and growth continues. Normal new leaves are developed, so that the final appearance is of a number of collapsed diseased leaves, below a normal development of rigid leaves. The growth of the tree is, perhaps, retarded for twelve months, but finally recovers.

Diseases of Other Crops.

DURING the last three years much attention has been given to the possibility of establishing agricultural industries, other than rubber and coconut cultivation, on an economic scale. The cultivation of the African oil palm is promising and the diseases so far encountered are similar to those of the coconut palm. Fibre plants of the Agave family have claimed considerable attention, but the leaves of these plants are generally strong and leathery, and do not form attractive feeding places for fungi. The plant *Hibiscus Sabdariffa* var. *altissima*, from which roselle fibre is obtained, appears very subject to eel-worm attacks. A bacterial disease, a wilt, and a die-back, are being investigated.

WITHER-TIP, a serious disease in the West Indies, has been observed on lime trees, which are now being cultivated on a plantation scale, but is causing little damage. A root disease, with symptoms similar to those shown in the case of rubber roots attacked by *Ustulina zonata*, has been under investigation. It is to be expected that the serious root

disease of lime trees in the West Indies caused by *Rosellinia bunodes* will be found in Malaya; this fungus has already been found killing young "kapur" stumps in this country. Pink disease has also been recorded on lime trees in Malaya.

SPECIMENS of diseased banana plants, Sea Island cotton, and castor oil plants, have been received for investigation. It may be expected that, if any of these crops are planted on a large scale in Malaya, serious plant diseases will appear.

INSECT PESTS.

IN the process of clearing jungle and growing a particular crop to the exclusion of all other plants, the natural balance of vegetation is upset. Insects which feed on related plants, finding abundant food material, will naturally increase to great proportions. As the cultivation of one kind of plant proceeds, the insects which feed upon it may be expected to become more abundant, for they find a plentiful and easily accessible supply.

LOCAL insects are not always, however, entirely responsible for the damage done to crops. Insects which may be established pests in their own country, or which might gradually become such in other surroundings, are often imported into a new country. Such imported insects are frequently more injurious than the local ones, since the latter are generally kept in check by birds, other insects and diseases. Imported pests are rarely accompanied by their natural enemies, and hence increase to great numbers and do enormous damage before they are attacked by the natural enemies of similar native insects.

LITTLE attention has been paid by planters in Malaya to the control of insects, but with the cultivation of crops other than rubber and coconuts the need will arise. Insects have been observed injuring all the economic plants cultivated experimentally or otherwise in Malaya. Insect pests can, however, be overcome largely by keeping the plants in good health by the application of sound agricultural principles, and by the judicious use of insecticides.

THE following notes on insect pests of economic crops in Malaya are not complete, and can only be described as a rough guide for those interested in planting in this country.

Pests of Coconuts.

THE most important insects attacking coconuts in Malaya are described below:—

Rhynchophorus schach, Oliv., (*Curculionidae*), (The "Red Stripe" Weevil).

THIS is an insect well-known throughout Malaya, but is not the most deadly, since it cannot attack sound trees. The larvae cause injury by boring through the tissues of the palm in all directions. When full grown they change to pupae inside cocoons, which are composed of twisted fibres.

THE female weevil lays eggs in damaged parts of the coconut palm. One-day old grubs have been found capable of entering a palm through the tissues of a petiole cut at a distance of 36 inches from the trunk, and weevils have been observed under natural conditions to lay eggs at the cut end of petioles.

THE female weevil may lay as many as 832 eggs and can commence egg-laying the day after emergence from the cocoon.

THE life cycle, from egg to adult, can be completed in 87 days.

THE weevil is an enemy of other economic palms, the African oil-palm being particularly susceptible, while most dead and dying palms serve as host plants.

CONTROL measures consist in preventing injury to the palms, caused either by mechanical or other means, controlling the "Black" or "Rhinoceros" beetle, (*Oryctes rhinoceros*), and in reducing the breeding grounds by destroying dead and dying palms.

Oryctes rhinoceros, Linn., (*Dynastinae*).

(The "Black" or "Rhinoceros" Beetle).

FAN-SHAPED leaves and holes in the petioles of palms are signs of the injury caused by the "Black" or "Rhinoceros" beetle. This insect is to be feared most in districts where the "Red stripe" weevil is present, since, by "boring" the crown of the palm, suitable conditions are set up for this weevil to lay its eggs.

THE grubs may be found in accumulations of vegetable refuse, manure heaps and decaying and dead palms, so that in the control of this insect particular attention should be paid to possible breeding grounds. Systematic collection of the beetles and disinfection of the holes in the tree are methods usually adopted on estates.

Plesispa reichei, Chap., (*Hispinae*).

(The Two-coloured Coconut Leaf-beetle).

BOTH the beetle and grubs of this insect are most injurious to young coconut palms up to two or three years of age. They feed between the unopened leaflets.

THE eggs are brown in colour and are laid on the leaves. They hatch in about 7 days and the grubs feed on the leaves for about 33 days, when they change to pupae, remaining in that state for about 7 days.

THE beetles have a yellowish coloured thorax and black wing-covers: the grubs and pupae are yellowish in colour.

NURSERIES should not be made under coconut trees, but should be prepared under other trees or under artificial shade. All attacked seedlings, before transplanting or "supplying," should be immersed in a solution of lead arsenate.

AFTER transplanting, if control is still considered necessary, the insect in its several stages should be hand-collected or sprayed with lead arsenate, particular attention being paid to direct the spray towards the centre of the palm.

Artona (*Brachartona*) *catoxantha*, Hamps., (*Zygaenidae*).

THIS insect is probably present in small numbers throughout Malaya, but only comes into prominence during a sudden increase, when the damage caused by the caterpillars gives the coconut leaves the appearance of having been scorched by fire.

THE caterpillars when full grown are about ½ inch in length and have conspicuous violet longitudinal markings: the moth has brownish coloured wings and a yellow body.

THE caterpillars cause a serious reduction in yield when they are present in large numbers, but so far they have always been controlled by their

natural enemies. It is said that control has been effected by mechanical means, but the action of its parasitic and predaceous enemies was probably not sufficiently considered.

CONTROL should consist in helping the natural enemies, but the inter-relation of host, parasite and hyper-parasite is at present so little known that no definite control measures can be given without further investigation.

ALTHOUGH outbreaks have so far only occurred locally, this pest is a serious menace to the coconut industry in Malaya. A sharp watch should be kept for the caterpillars, and their presence reported immediately to the Department of Agriculture.

Setora nitens, Walk., (*Limacodidae*), and *Hidari irava*, Moore, (*Hesperiidae*).

SEVERAL caterpillars feed on the leaves of the coconut palm, the above-named species being about the most prominent.

Batrachedra arenosella, Walk., (*Cosmopterygidae*).

(The "Lesser" Coconut Spike-moth).

THE caterpillars of this moth bore into the unopened spike and feed on the female and male flowers, occasionally completing their life-cycle before the spike opens.

RECENT observations indicate that other causes are also responsible for a large proportion of the fall of female flowers and immature nuts, but this insect is undoubtedly responsible for the loss of a certain proportion of nuts, and is probably the most serious pest on the coconut spike.

CONTROL measures have been worked out which effect a reduction of over 80 per cent. of female flowers attacked, but it is too early to state whether such methods would be an economic proposition.

Tirathaba sp. near *trichogramma*, Meyr., (*Pyralidae*). (The " Greater " Coconut Spike-moth). CATERPILLARS of this moth are often found damaging and sometimes boring right into the female flowers, just after the spike has opened. They feed to a large extent on the male flowers, and especially on those which have fallen and accumulated at the base of the spike.

THE amount of damage varies, but has been considerable in some cases. Palms which are attacked should be cleaned up, and the accumulations of fallen male flowers at the base of the spikes removed and burned.

Pests of Rubber.

RUBBER is the most important crop in Malaya, but its insect enemies are remarkably few. Caterpillars such as *Acanthopsyche snelleni*, Heyl., (*Psychidae*), are occasionally found injuring the tapping surface, and others, such as *Euproctis* sp., (*Lymantriidae*), injuring the leaves but never extensively. The Termite, or " White Ant," *Coptotermes gestroi*, Wasm., is by far the most injurious pest of the rubber tree. Clean-clearing of timber, thereby destroying suitable nest logs, will result in the control of this Termite.

THE application of control measures, however, are not sufficiently practised, and there is a tendency to apply superficial and merely temporary remedies.

Objections to the employment of sound preventive measures are frequently made on account of the initial cost, but the wisest policy to follow is undoubtedly clean-clearing, since the danger from "White Ants" and fungus diseases is thus greatly reduced.

Platypus lepidus, Chap.

THIS Scolytid beetle is not a pest of healthy rubber trees, but is always ready to enter damaged trees. Rubber trees scorched by leaf fires are particularly subject to attack.

Hemithea costipunctata, Moore.

CATERPILLARS of this Geometrid moth may be found during the whole year feeding on the flowers of rubber trees. Although not at present of economic importance, this insect would reduce the yield of rubber seeds for the extraction of oil.

Pests of Padi.

RICE in Malaya, although grown sometimes on estates to provide food for the coolies, is essentially cultivated by the Malay. Several insects cause a reduction in the yield; these may be conveniently classified as (1) sucking insects, (2) boring caterpillars and (3) leaf-eating caterpillars.

(1) Sucking Insects. The most important are *Scotinophara coarctata*, ("Kutu Bruang"), and *Leptocorisa* spp., ("Pianggang"), and although others attain local significance from time to time, enquiries concerning these major pests have been more numerous.

Scotinophara coarctata, Fb.

THIS Pentatomid, called " Kutu Bruang " in Malaya, is black in colour, and about ½ inch in length. The nymphs and adults suck the sap from any part, but especially from the lower portions of the plant.

ATTENTION should be paid to the seedlings when transplanted from the nurseries, to see that all plants are free from eggs, nymphs and adults. When the irrigation water can be controlled, the padi should be flooded. Nymphs and adults rising to the surface of the water can then be collected. All stages of this insect can exist on stubble and volunteer padi growing between padi crops, so that consideration should be given to the disposal of the stubble and to the prevention of the growth of volunteer padi.

Leptocorisa spp., (" Padi Fly," " Pianggang ").

THIS Coreid bug, which is probably the most serious pest of padi, sucks the sap from the developing padi grains.

THE adult is recognised by its greenish brown colour and elongate body. The eggs, which are laid on the upper surface of the leaves, are brownish in colour and very conspicuous, being laid in chain formation parallel to the mid-rib of the leaf. They hatch in about 7 days and the nymphs, in common with the adults, suck the sap. The adult condition is attained after a period of about 18 days from the hatching of the egg.

THIS insect lives on the inflorescences of several grasses until the padi begins to ripen and after the crop has been harvested, so that grasses should be

kept down as much as possible in padi areas. When the crop is growing, the insects may be reduced by collecting the eggs, nymphs and adults.

Nephotettix bipunctatus, Fb., (*Jassidae*), and *Nezara viridula*, Linn., (*Pentatomidae*).

THESE two bugs are not very serious pests, but occasionally reduce the yield of padi, the former by sucking the sap from any part of the aerial portions of the stem, and the latter by sucking the sap from the developing grain. *Nephotettix bipunctatus* is attracted to light and may be controlled by light traps. *Nezara viridula* should be collected and destroyed.

(2) "Boring" Caterpillars. The caterpillars of the Pyralids, *Siga* (*Schoenobius*) *incertellus* (*bipunctifer*), Walk., *Chilo simplex*, Butl., *Diatraea* sp., and the Noctuid, *Sesamia inferens*, Walk., are all found boring the stems of the padi plant, and cause a reduction in the yield as well as uneven ripening. Clean cultivation should be employed for the control of all these insects.

(3) Leaf-eating Caterpillars. A large variety of caterpillars included as leaf-eating are usually present, and from time to time do considerable damage.

THE caterpillars of *Parnara mathias*, Fb., (*Hesperiidae*), which roll the leaves of padi and feed inside them; of *Melanitis ismene*, Cram., (*Nymphalidae*), of *Nymphula depunctalis*, Gn., (*Pyralidae*), which are semi-aquatic; and of *Spodoptera pecten*, Gn., (*Noctuidae*), which is very sporadic and generally limited at first to a small area, all cause some damage to padi.

Control of Padi Pests. From an entomological point of view, the practice of allowing stubble and self-sown padi to grow, after harvesting the main crop, is extremely unsound. Several of the more important enemies of padi feed on wild grasses and, as long as these are allowed to grow unchecked, they provide ideal breeding grounds for insects which attack the next crop of padi.

THE eggs of the more serious insects are conspicuous on the leaves, especially of seedlings, and should be destroyed.

Pests of Cotton.

COTTON is a comparatively new crop in Malaya, and has not yet been planted on any large areas. The pests are therefore not by any means fully recorded, although those already observed indicate that the control of insects will be one of the principal factors in obtaining successful cotton crops. The wide distribution of other plants of the natural order *Malvaceae*, such as *Hibiscus* spp. and "Kapok," (*Eriodendron anfractuosum*), provides alternative food plants for a large number of cotton pests. The "Mexican" Boll-weevil, (*Anthonomus grandis*, Boh.), has not appeared in Malaya. The most important recorded pests are described below:—

Platyedra gossypiella, Saund., (*Gelechiadae*).
("The Pink Boll-worm").

THIS insect is the most dangerous pest of cotton in Malaya, although at present it is not very common. Great damage is done to the lint and seed, and the yield of both is seriously reduced. The whole larval and pupal life is passed in the boll, and the life-cycle is completed in just over a month;

hibernation may take place in the seed, although it is doubtful whether this occurs in seed grown in this country.

THE salient points in control are the creation of close seasons and the treatment of seed prior to sowing.

Earias insulana, Boisd., and *Earias fabia*, Stoll., (*Noctuidae*).

THE "Spotted Boll-worms" are present throughout Malaya. Before the bolls are formed the young shoots are "bored" by the caterpillars. Pupation takes place on the plant or in the ground.

THE bolls may be hand-picked as soon as signs of the attacks appear, but the chief control measure consists in the removal of all cotton bushes after the crop has been harvested, and in the destruction of all alternative food plants.

Heliothis obsoleta, Fb., (*Noctuidae*).

("The American Boll-worm").

THE larvae of this moth feed on a large number of plants, but cause serious injury to cotton, maize and tobacco.

LARGE numbers may be killed by the use of arsenical dusts. The removal of all alternative food plants is the best preventive.

Sylepta derogata, Fb., (*Pyralidae*).

("The Cotton Leaf-roller").

THE caterpillars of this moth roll and feed on the leaves, sometimes completely stopping the growth of the plant. By immediate attention, the attack can be stopped by the collection of the caterpillars and

by the use of arsenical dusts or sprays, but reinfection soon takes place, if alternative food plants are not destroyed.

Dysdercus cingulatus, Fb., (*Pyrrhocoridae*).
(" Cotton Stainer ").

THE boll is punctured by this insect in feeding, and bacteria are thus introduced, which discolour the lint.

THE nymphs or young forms congregate together on the bolls and on the ends of branches, and can be shaken into a bucket containing water, covered with a film of kerosene. The nymphs are particularly susceptible to *derris* (" tuba ") in spray form.

Pests of Kapok or Silk Cotton.
(*Eriodendron anfractuosum*).

KAPOK is liable to be damaged by several " boring " insects. The grubs of a species of weevil, *Alcides leeuweni*, Hllr., (*Curculionidae*), tunnel the young twigs and hinder the growth of the plant. All the damaged twigs containing the grubs should be cut off and destroyed.

Zeuzera coffeae, Nietn., (*Cossidae*).

THE caterpillars of this moth, in addition to boring the branches and stems of coffee, tea and other plants, tunnel those of kapok and occasionally do considerable damage. The caterpillars should be cut out of the stem and destroyed.

Dysdercus cingulatus, which has been mentioned as a pest of cotton and roselle, is also an enemy of this plant.

Pests of Bananas.

BANANAS are grown by Asiatics throughout Malaya, but no pest has become in any way serious.

Cosmopolites sordidus, Germ., (*Curculionidae*).

THIS is reported to be a serious pest in other countries, but has made little progress here. Damage is confined to the root and the base of the stem, in which the grubs bore.

A banana plant which looks sickly should be inspected and, if this weevil is present, the plant should be uprooted and burnt. All old stumps should be removed and destroyed and new suckers should only be planted if they are uninfected.

Erionota thrax, Linn., (*Hesperiidae*).

THE caterpillars of this "Skipper" are to be found wherever bananas are growing, living inside the strips of leaf, which they roll up into a cylinder. They do little damage and are largely kept in check by numerous parasites.

Pests of Citrus.

AT present citrus fruits are not grown on a commercial scale to any extent, and the pests have therefore received very little attention.

Orpheides malayanus, Wallace, (*Papilionidae*).

A number of Papilionid caterpillars feed on citrus leaves, but this one is most often seen. The whole life-cycle takes place on the plant.

THE caterpillars are not easy to see, and marked colour changes occur during their life. In small nurseries they are easily collected, while spraying is effective on a large scale.

Attacus atlas, Linn., (*Saturniidae*).

(The "Atlas moth").

OWING to the enormous size of the caterpillars of this moth considerable damage may be done in a short time. With careful supervision, however,

they should never be allowed to reach the full grown state, but should be collected when small, before they have been able to do much damage. The eggs, which are laid singly, are conspicuous objects and should be destroyed.

Prays citri, Mill., and *Prays endocarpa*, Meyr., (*Hyponomeutidae*).

THESE are the most destructive citrus fruit pests in Malaya at the present time.

THE minute caterpillars bore in the rind, rarely eating the fruit itself. In doing this, however, bacteria, fungi and other insects, such as the beetle *Carpophilus dimidiatus*, Fb., (*Nitidulidae*), and fruit-flies, are enabled to work havoc with the fruits.

NO satisfactory method of control has yet been worked out for this insect but, if the fruits are covered when young, they can be secured from the pest for table purposes.

Crocidomera robusta, Moore, (*Pyralidae*).

THE pomelo is subject to attacks by the caterpillars of this moth, which lays its eggs on the fruits. The caterpillars bore into the fruit and make it quite unfit for table purposes.

THE moth is not nearly as destructive as is thought, considerable confusion having arisen between the damage caused by it and that caused by *Prays endocarpa*.

POMELOES are not grown on a commercial scale, so that bagging the fruit has the desired effect.

Coccidae, ("Scale" Insects).

MANY "Scale" Insects occur, but not usually in large enough numbers to cause any serious injury. Enquiries are frequently made concerning a black

sooty mould which is seen on the upper surface of the leaves. This is not a parasitic growth, but a fungus feeding on the sugary substances excreted by "scale" and other small sucking insects. The mould interferes with photosynthesis in the leaves, and may be controlled by spraying the insects with kerosene emulsion or rosin compound.

Pests of Nipah Palm.

THE cultivation of this palm has recently been commenced on a commercial scale. The injurious enemies recorded are *Plesispa nipa*, Maulik, (*Hispinae*), and an unidentified species of crab.

BOTH the adults and grubs of the beetle feed on the surface of the leaf, and are similar in appearance to the stages of *Plesispa reichei*, Chap. The eggs of *Plesispa nipa*, however, are laid in groups, varying in number from 2 to 6. Control measures against this insect have not yet been found necessary. CRABS cause considerable damage to the young plants, especially after they have been transplanted from the nursery. In order to protect the palms at this critical period the employment of locally made appliances to protect the plants has been found effective.

Pests of Roselle.

INSECTS attacking this plant are similar to those which attack cotton, *Dysdercus cingulatus* especially being generally in evidence.

Sphaeroderma sp., (*Halticinae*).

THIS beetle, which is about 1/8 inch long and has shiny green wing-covers with a reddish coloured thorax, causes considerable damage by eating small

holes in the leaves of roselle, and spraying measures have frequently to be employed for its control.

Pests of Maize, Ragi and Sorghum.

THE pests of these plants are very similar to those of padi. Probably the worst pest of maize is *Heliothis obsoleta*, Fb., the caterpillar of which feeds on the cobs, and is best controlled by hand-picking.

Pests of African Oil-Palm and Sago Palm.

BOTH these palms are susceptible to the attacks of some of the pests of coconuts. *Rhynchophorus schach*, Oliv., probably prefers the sago palm to the coconut.

AFTER the operation of frond-pruning of African Oil-palms, all wounds should be carefully treated with some disinfectant, otherwise conditions are set up which enable this weevil to lay eggs.

Pests of Tobacco.

THE tobacco plant is attacked by several pests, of which probably the more important are the caterpillars of *Psara submarginalis*, Swinh., (*Pyralidae*), and of *Heliothis obsoleta*, Fb., (*Noctuidae*).

THE caterpillars of the former moth may be found in large numbers rolling the leaves of the tobacco plant; and those of the latter, although feeding slightly on the larger leaves, confine their attention essentially to the young shoots.

HAND-PICKING should be done but, in severe cases, spraying or dusting with lead arsenate should be adopted under supervision.

Pests of Sugar Cane.

THE most important enemies of sugar cane are "boring" caterpillars, although several sucking and leaf-eating insects have been recorded.

THE chief "boring" caterpillars in Malaya are the Pyralid, *Topeutis rhodoproctalis*, Hamps., and the Cossid, *Phragmataecia parvipunctus*, Hamps. The latter is rather interesting, since our records do not show its existence as a pest in other countries.

CONTROL measures for sugar cane pests should always be proceeded with rigorously. All eggs should be collected, "dead hearts" cut out and destroyed, and clean cultivation practised.

Pests of Tea.

THE cultivation of the tea plant in Malaya is not of great importance, but wherever the plant is grown in this country it is subject to attacks from the "borers" *Xyleborus fornicatus*, Eichh., (*Scolytidae*), *Zeuzera coffeae*, Nietn., (*Cossidae*); and leaf-eating caterpillars such as *Amsacta lactinea*, Cram., (*Arctiidae*).

Zeuzera coffeae has already been mentioned under pests of "kapok."

IF the caterpillars are abundant, spraying the plants with lead arsenate should be done under supervision.

Pests of Coffee.

ONE of the chief pests of this plant is the moth *Cephonodes hylas*, F., (*Sphingidae*), but since the caterpillars feed exposed on the leaves they are not difficult to control.

THIS clear-winged hawk-moth may be seen flying very quickly from one coffee plant to another and, if the leaves on which it settles are examined, small greenish eggs laid singly will be found. The eggs are generally laid on the young leaves.

Pests of Derris. ("*Tuba*").

SEVERAL species of *Derris* suffer from attacks of leaf-eating caterpillars such as *Mahasena* sp., (*Psychidae*), *Hasora alexis*, F., (*Hesperiidae*), and several others. It would appear that the toxic substances in the roots and stems of these plants are not present in the leaves and, in some species, this has been found to be the case. *Serixia* sp., (*Lamiidae*), has been found boring in the bark of *Barringtonia speciosa*, which is one of the tuba plants. It is not yet known, however, whether this plant is of any use against insects.

THE plants on which pests have been found are in the experimental stage, and those finally selected for the production of insecticides may be found to be immune to insect attack.

Pests of Other Crops.

INFORMATION concerning insects attacking mango, pineapple, castor, pumpkins, gourds and other cucurbitaceous plants, brinjal, gingelly, candle-nut, ground-nut, patchouli, vanilla, cloves, nutmegs, pepper, cinnamon, ipecacuanha, cocaine, cinchona, sisal, Manila and Mauritius hemps, gambier, betel-nut, gutta percha, tapioca and other plants has also been recorded.

General Crop Pests.

A large number of caterpillars and grasshoppers do not confine themselves to any one crop, but may be found attacking many unrelated plants. Owing to

various causes, they may increase rapidly and become a serious danger. The difficulty of dealing with insects of this type is, however, nearly always increased by the fact that the cultivator fails to report their presence sufficiently early.

AMONG the caterpillars, which are very general feeders on low-growing crops, those of the following moths, (*Noctuidae*), may be mentioned:—

Prodenia litura, Fb., *Spodoptera mauritia*, Boisd., *Spodoptera pecten*, Gn., *Agrotis ypsilon*, Rott.

THE caterpillars of the moths *Creatonotus* spp., (*Arctiidae*), *Euproctis* spp., (*Lymantriidae*), *Tiracola plagiata*, Walk., (*Noctuidae*), are also fairly general feeders, those of *Tiracola plagiata* being especially liable to attack plants growing adjacent to jungle.

THE control of these insects will depend on local conditions and on the particular crop attacked. In general, since these are biting insects which eat the leaves and stems, spraying with a poison such as lead arsenate is the method of control indicated.

Araecerus fasciculatus, De G., (*Anthribidae*). THIS small beetle is responsible for much damage to seeds in the field and store. The eggs are laid singly, one near each seed, which the grub destroys, later pupating inside the pod. In some cases only five per cent. of the seeds escape damage.

IN the case of growing plants a thorough pruning, to remove all ripe and unripe pods, is effective, but a distance of 500 to 1,000 yards must be left between pruned areas which have been attacked, and unpruned unattacked areas.

Hypomeces squamosus, Fb. (*Curculionidae*).

THIS weevil is very common in Malaya and, when present in large numbers, does considerable damage by eating the leaves of various plants. It is particularly bad on kapok, which is only in leaf for a short time. Breeding takes place in the soil on the roots of various grasses and cover-crops.

SPRAYING with lead arsenate causes some reduction but, should the insect be present in large numbers, the ploughing up of grass and cover-crops all round the area attacked will have to be considered.

Anomola cupripes, Hope. and *Adoretus compressus*, Weber. (*Rutelinae*).

THESE insects are night-feeding, leaf-eating beetles. As in the case of *Hypomeces squamosus*, breeding takes place in the roots of various cover-crops and grasses, and control measures are similar to those given above.

Valanga nigricornis, Burm., and *Cyrtacanthacris luteicornis*, Serv.

NUMEROUS grasshoppers, (*Acridiidae*), are always present; the two mentioned above are typical. With this class of insect it should be remembered that the young form is like the adult, only without wings, and that the young nymphs begin feeding almost as soon as they hatch out from the eggs. Control measures vary with conditions, but the use of poison sprays and baits, the spraying of grass or cover-crops where the insects congregate and the destruction of egg-masses by cultivation, where possible, are methods usually adopted.

IT has been observed that cover-crops harbour grasshoppers in large numbers, and instances have occurred where young coconut palms were only

attacked when there was a cover-crop on the ground. Adjoining areas with no cover-crop were not attacked.

Locusts. (*Acridiidae*).

LOCUSTS are grasshoppers of certain species which, from various causes, suddenly increase to incredible numbers, swarm and migrate. Except for this habit, which recurs at intervals, the locust is an ordinary grasshopper.

THERE has been one serious outbreak of locusts in Malaya. *Locusta migratoria*, L., phase *migratorioides*, Rch. and Frm., (Syn. *Pachytylus capito*, Sauss.) first appeared near a port, and this led to the belief that the locust was an imported one, which is unlikely. Although no permanent breeding grounds have been found, which are characteristic of locusts, it must be remembered that the finding of such places is extremely difficult, owing to the impenetrable nature of the forests. It is in such localities that the locust exists in small numbers, awaiting favourable conditions before again swarming and migrating.

THE measures necessary for dealing with locusts cannot be treated here, but should any indication of a migratory habit of grasshoppers be observed, the fact should be reported immediately to the Department of Agriculture.

Pests Attacking Stored Products.

IN controlling this type of insect, the chief difficulty in this country is that store-houses are rarely built in such a way as to make fumigation possible with any degree of ease. Recourse must therefore be had to other methods, which depend on circumstances.

As a preventive, rigorous cleanliness in factory and store-room will do much to prevent the increase of insects attacking stored products.

Calandra oryzae, Linn., (*Curculionidae*), is the most serious pest of stored grain, and attacks rice in Malaya. It requires 10 per cent. of moisture for development, so that, if grain can be kept bone-dry, there is no danger of attack.

Sitotroga cerealella, Ol., (*Gelechiadae*), is a moth which lays its eggs in grain, the caterpillars doing considerable damage at times.

Lasioderma serricorne, Fb., (*Ptinidae*), is a small beetle which does extensive damage to manufactured tobacco. It also attacks groceries, drugs, tapestry, silk and other articles.

Tribolium castaneum, Herbst., (*Tenebrionidae*), attacks pulses, grain, flour and such articles as rubber-seed cake.

Necrobia rufipes, Fb., (*Cleridae*), is a minor pest of dried animal products, but also feeds on stored copra. It is attracted to artificial light, and first came to the notice of the Department on account of complaints from residents living near copra stores.

Ephestia spp., (*Pyralidae*), are pests on flour and dried vegetable matter, the caterpillars making a large amount of webbing and matting the material together.

HOUSEHOLD AND OTHER INSECTS.

In addition to those attacking crops, there are certain insects against which the planter must be on his guard. House-flies, fleas, and mosquitoes are

carriers of disease, while bed-bugs and cockroaches are under suspicion. It is most important that information should be obtained concerning these insects in Malaya.

OTHER insects may seriously damage the house and its contents, the most important of which are Termites, (White Ants).

TERMITES are universal feeders, but make a speciality of wood. They work entirely under cover, shunning the light, and hence the damage is usually complete before they are discovered. They are particularly troublesome in houses, eating into the main timbers, floors, and even into the furniture. Prevention is better than cure, and houses should be constructed with a view to keeping them out.

ALL houses should be built preferably on raised masonry piles and, where the main timbers rest on these piles, a layer of iron should be placed between the masonry and the wood, since the former generally cracks and allows the insects to come up from the ground. Wood scrap from the building operations should not be left in the ground under the house, as this attracts Termites, and a periodical inspection should be made under the house to ascertain whether the runs, which the insect makes, are on the surface of the masonry. All timber used in the construction of the house should be treated with hot creosote, which preserves it for a long time against Termite attack.

IF the runs are observed on the masonry they should be traced back to the nest and a sulphur-arsenic mixture in a "White Ant Pump" should be used. It is important that every part of the house should

be accessible underneath. Bath-rooms and outbuildings should preferably be raised, and not built on the ground, as is frequently done.

IN the case of temporary outbuildings, main timbers should not be sunk in the ground, but should be sunk in concrete, after being treated with creosote.

Insecticides.

THE following notes give a simple method of preparation for insecticides obtainable in this country.

Arsenate of Lead. According to circumstances, from 2 to 10 lbs. of the powder may be used in 100 gallons of water. The quality obtainable at present is uncertain and burning of the leaves of plants sprayed with this solution should be watched for.

IT is sometimes impossible to obtain an even spread by the use of water alone, and soap may have to be added in the proportion of 5 lbs. to 100 gallons of water. This has the effect, however, of increasing the liability to burning but, if the quality is attended to and only an *Oleic acid* soap used, this danger is reduced to a minimum.

Kerosene Emulsion. This is used for sucking insects and kills by contact, not by injestion. It consists of a mixture in the proportion of water (1 gallon), soap (½ lb.) and kerosene (2 gallons).

DISSOLVE the soap in the water by boiling, remove from the fire, and stir in the kerosene to make a creamy emulsion. The emulsion is readily obtained by the use of a garden syringe. Crude oil can be used instead of kerosene. For spraying, the emulsion is diluted by using 1 part in 10 to 20 parts of water.

Rosin Compound. For "scale" and other small sucking insects, rosin compound is a simple and effective insecticide. Powder 2 lbs. of rosin, and boil 1 lb. of washing soda crystals in a gallon of water. Add the powdered rosin to the boiling soda solution and keep the mixture boiling, adding more water at intervals as the liquid boils up, until the mixture turns clear, like thin coffee. This will make about 3 gallons of solution, which should be diluted in the proportion of one part to eight of water for spraying.

Tobacco Wash. One pound of tobacco stems steeped in four gallons of hot water and cooled, to which four ounces of soap is added, makes a simple wash for Thrips and other small sucking insects.

Derris. ("Tuba"). For small caterpillars and sucking insects, where a simple wash is required, the derris spray can be made on the spot, using the following proportions:—Derris root (4—5 lbs.), soap (2 lbs.), water (50 gallons).

CUT the derris root into small pieces and pound to a pulp in a mortar with a little water. Enclose the pulp in a cloth and squeeze well in a larger quantity of water. To the extract obtained by the above process add the soap, which has been dissolved in a little hot water. Then dilute to 50 gallons.

Soap Solution. This is the simplest insecticide obtainable and is quite effective for many Aphids and small sucking insects. One pound in 5 gallons of water is an average strength.

"White Ant" Fumigant.	This consists of a mixture of sulphur and arsenic trioxide for use in the "White Ant Pump," and can be bought in this country ready mixed.

INSPECTION AND CONTROL OF PESTS.

In the following notes the term "pest" is used as defined in the Agricultural Pests Enactment referred to below and includes insects, invertebrate animals, rodents, plants and fungi injurious or liable to be injurious to cultivated plants.

A staff of adequately trained inspecting officers can do much to guard against the attacks of epidemic pests by enforcing control measures generally, by reporting immediately to research officers the discovery of any new pest on a crop, and by preventing the introduction of pests from foreign countries.

In the Federated Malay States and Straits Settlements such a staff exists, together with necessary legislation for the enforcement of such measures as may appear desirable to ensure effective control.

The inspection and control of pests in Malaya began in the first instance in connection with the control of two serious pests of the coconut, the rhinoceros or black beetle (*Oryctes rhinoceros*, Linn.) and the "red stripe" weevil (*Rhyncophorus schach*, Oliv.).

The rapid development of plantation rubber cultivation rendered it necessary to extend the work of inspection, and in 1913 a Chief Agricultural Inspector was appointed to organise an Inspection Division of the Department of Agriculture responsible for the control of pests on all crops in the Federated Malay States. This Division also became responsible

for pest control in the Straits Settlements in 1918 when the Department took charge of agricultural work in that Colony.

In the early days of the newly formed Division an epidemic of an exotic species of locust required prompt attention. The control measures instituted in this instance were so effective that the pest was exterminated.

The control of the two coconut beetle pests previously mentioned has received and is still receiving, systematic attention. Control of the various well-known rubber diseases is also a matter of routine. Pest control, in addition, includes the insistance upon a certain degree of estate sanitation in so far as the lack of such is likely to create favourable conditions for the entry and spread of disease. Estate sanitation consists mainly of the destruction by fire of dead rubber trees and the prevention of such bad and excessive tapping as will render the tapping surface liable to disease. Lalang, a coarse grass, which damages cultivated plants by weakening and retarding their growth, is considered to come under the term " pest " and its eradication is insisted upon, so far as is practicable. Complete control of this noxious weed during the recent rubber slump period was, in many instances, not economically possible, but the stricter policy which was practised before the slump, is now again followed.

Any new line of work, or the control of any new pest, requires much instructional work among small-holders before measures to enforce action can fairly be taken. Pamphlets and posters in Asiatic

languages are issued for this purpose and field demonstrations are given. This educational work is an important function of the Inspecting Officers.

At the present time, in the Federated Malay States and Johore, pink disease and mouldy rot are the most important pests of rubber requiring constant attention, while in the Federated Malay States and the Colony much time is being devoted to experimental measures for the control of various padi pests.

Enactments and Ordinances.

In the Federated Malay States, The Agricultural Pests Enactment was passed in 1913. This empowers Inspecting Officers to enter on any agricultural land and inspect the plants growing on it. If the cultivated plants are attacked by any pest, or if the land or the plants are in a condition favourable to the introduction and/or spread of any pests, the Inspecting Officer can order the owner or occupier of the land to take such action as he may consider necessary for the treatment or control of the pest. This order is in the form of a notice stating the action to be taken and the time within which it must be completed. If the owner or occupier fails to do the work satisfactorily, the Inspector can enter the land and have the work done, after which the Secretary for Agriculture, or such other officer to whom the Secretary may have delegated powers, may authorise recovery of the cost by civil suit. For wilful neglect to comply with an order, the owner or occupier of the land can be prosecuted by the Inspector, if so authorised by the Secretary or other officer to whom the Secretary may have delegated powers, and can be fined. Inspecting Officers can thus control existing known pests of crops and

can report promptly to the research officers the appearance of new pests. Thus protection is afforded against indigenous pests. The Enactment also gives the Chief Secretary to Government power to make rules requiring the notification to Inspecting Officers of any pest likely to assume dangerous proportions. It further empowers the Chief Secretary to make rules regulating the importation of plants from outside the country, and thus affords protection from introduced pests.

In Johore, a similar Enactment was passed in 1914. This is now replaced by a revised Enactment of 1921. In the Straits Settlements, The Agricultural Pests Ordinance No. 166 is very similar to the Federated Malay States Enactment.

The Inspecting Officers in the Federated Malay States also administer the Water Hyacinth Enactment, No. 17 of 1917, which provides for the destruction of this noxious weed by the owner of the land on which it is growing, or in the event of his failure to do this, by an Inspecting Officer at the owner's expense.

Rules under these laws require the notification to the nearest Assistant Inspector, or to the Chief Agricultural Inspector, of the following pests:—

Brachartona catoxantha, Hamps., (Syn. *Artona catoxantha*, Hamps.), a caterpillar attacking the leaves of coconuts.

Pink Disease of Rubber (*Corticium salmonicolor*, B. and Br.).

Mouldy Rot of Rubber (*Sphaeronema* sp.).

Black Stripe of Rubber (*Phytophthora* sp.).

Further rules lay down the conditions under which sugar-cane and cotton may be imported into the

Colony or the Federated Malay States; and others prohibit the importation of Para rubber, or any species of *Hevea*, except with the permission of, and under the conditions laid down by the Secretary for Agriculture or such other officer to whom the Secretary may have delegated powers.

A good deal of consideration has been given recently to the question of a more effective and systematic control of plant importation, and to the measures necessary to ensure that only healthy plants shall be exported. Rules have been submitted and will become law very shortly, making provision for the establishment of certain definite ports of entry through which alone plants may be imported. Under these rules, qualified officers will be responsible for the inspection of plants at these ports and such officers will have power to admit, require the treatment, or order the destruction of plants as they may deem necessary.

On application for their services by intending exporters, certain Inspecting Officers of the Agricultural Department, Federated Malay States and Straits Settlements, are legally authorised to sign certificates of freedom from disease to accompany consignments of plants intended for export; such certificates being required by law in Great Britain and many other countries.

Peat.

Peat.

IN order to appreciate the importance of the problem of utilising peat deposits, it is only necessary to realise the extent of the surface of the globe which is covered by peat bogs. In Europe alone this area amounts to 212,700 square miles.

IN Malaya it is not possible to state exactly the area of peat, but it represents a fair proportion of the total area, and the necessity for considering the problem here is probably as important as it is elsewhere.

PEAT should not be regarded merely as a waste material, and the areas covered by it as useless. It consists of decomposing vegetable matter saturated with water, and contains valuable compounds such as cellulose, organic nitrogenous bodies, complex hydrocarbons and mineral salts which, by suitable treatment, can be transformed economically into substances of industrial importance.

INVESTIGATIONS in connection with this problem have been carried out in the past, and there is much information available on the possible uses of peat as a fuel, and for the production of alcohol, paper, ammonia and acetic acid.

Alcohol from Peat. In 1907 it was stated by a special committee of the Motor Union appointed to consider the advisability of substituting another fuel for petrol "that alcohol offers the most complete and satisfactory substitute for petrol, and alcohol production would form a home industry if peat were utilised as the raw material."

As a result of the findings of that committee, the subject of the production of alcohol from peat received renewed attention. Wet peat, when mixed with acidified water and boiled under a low steam pressure, yields saccharine substances which, after neutralisation with lime, can be fermented to alcohol by the use of a special yeast. It is recorded that, in his original investigations, Sir William Ramsay extracted six gallons of alcohol from one ton of wet peat.

Subsequent investigations indicated that one of the most important points is to arrest the acid digestion of the peat at the right stage; otherwise the sugars at first formed are attacked and destroyed, and the further formation of sugars produced by the decomposition of the cellulose in the peat does not compensate for the loss of the original sugars.

A firm in Copenhagen has developed and is working a process on a large scale for the extraction of alcohol from peat, and it is stated that about forty gallons of absolute alcohol, together with sixty-six lbs. of sulphate of ammonia and other valuable by-products, are obtained per ton of dry material. It is claimed that the cost of the alcohol is only $4\frac{3}{4}d.$ per gallon.

In this country the subject has only recently received attention from the Department of Agriculture; but, as far as the work has progressed, it has been shewn that the peat obtained can be treated in a manner very similar to that used in the original process referred to above.

AFTER the peat has been treated for alcohol production, there remains a bulky residue which, after drying, forms a very suitable fuel, and also contains valuable nitrogen compounds.

Peat as a source of Paper The cellulose in the residue from the alcohol process, or from fresh dry peat, can be converted to a pulp capable of being manufactured into a fair-quality blotting paper, rough brown packing paper, or cardboard.

THERE appears to be no suitable economic process for completely bleaching the peat fibres for the production of pure white paper but, in view of the large demand for packing wrappings, a light brown or yellow colour is not a grave objection.

IN one of the most successful processes for the manufacture of cardboard the peat is saturated with water containing a small proportion of bromine, which attacks the gummy substances surrounding the fibres and renders them more soluble in an alkaline solution. The mass is thoroughly agitated and soda-ash is subsequently added; the mixture is then heated for about five hours under steam pressure. After the digestion, the alkaline lye can be drained away and the resulting fibrous mass washed thoroughly with water. If desired, this can be partially bleached by the usual treatment, with chlorine water or bleaching powder solution. The fibres are then beaten in an ordinary Hollander and, when the half-stuff is ready, it may be run to the paper-making machines alone, or may be incorporated with half-stuff from other sources for the manufacture of almost any type of paper.

EXCELLENT blotting paper is made from this material and is said to be particularly absorbent and satisfactory, owing to the hydrated state of the cellulose in the original peat.

Peat as a Fuel. In this country the production from peat of an efficient fuel appears to be a matter of importance. The industrial development of a country depends largely on its fuel supply, and peat exercises its most important function in industry as a source of fuel.

IF the peat deposits of Malaya can be utilised as supplies of fuel, a great step will have been achieved in the industrial progress of the country.

IN order to appreciate fully the possibilities of peat fuel, it must be remembered that the solid matter of peat consists very largely of carbonaceous matter, and that under suitable conditions of combustion this will behave like a soft coal, and yield distillation products which are inflammable and of high calorific value. Apart from the conversion of peat to briquettes, for burning in an open hearth or under forced draught, there is the possibility of destructive distillation of the carbonaceous matter in order to obtain tarry distillates and a gaseous product that can be either stored or utilised directly in gas engines as a source of power.

IN the production of this gas from a still or from a gas producer, the peat yields also a large proportion of liquid distillate, which is a mixture of many valuable materials, including acetic acid, ammonia and tar. It is considered that the production of these alone (and not merely as by-products) will yield a reasonable margin of profit.

INVESTIGATIONS conducted at the Department of Agriculture have shewn that the peat deposits in the west of Selangor are eminently suitable for distillation. It has been found that one hundred pounds of air-dried peat yield, on an average, three hundred cubic feet of gas. This has a good calorific value and can be used to replace coal gas or oil gas produced by cracking kerosene oil. The peat also contains over 1.5 per cent. of nitrogen which, under suitable conditions, can be transformed into ammonium sulphate.

THE combustion of peat in an ordinary charcoal producer has also produced instructive results. It was found that a National gas engine could be successfully run on peat gas and the consumption was only 400 lbs. of fuel per hour.

THE water-content of the peat is an important factor in the composition of the gas which is evolved during combustion in a producer. When peat is excavated it contains usually between 70 per cent. and 80 per cent. of water, a proportion of which must be removed before the material will burn. Drying can be effected quite satisfactorily in this climate by allowing the peat to remain exposed to the air for a fortnight, during which period the water-content will have been reduced to 40 per cent. or 50 per cent. and the mass rendered suitable for charging direct to the producer. In some cases it may be necessary to start operations by a charge of very dry peat containing only 10 per cent. of moisture but, the greater the proportion of water which can be decomposed with the carbonaceous matter, the more efficient the process becomes. Gases such as Mond gas, blue gas, water gas and

others of similar type are manufactured by introducing live steam into the bottom of the producer; in the present instance it has been found that, if the producer can be made sufficiently hot, it is possible to decompose peat containing 60 per cent. of moisture. The gas consists of a mixture of hydrogen, carbon monoxide, methane, and carbon dioxide, and has a calorific value of approximately 135 B.T.U. per cubic foot.

NATURALLY there is a greater proportion of liquid by-products obtained during the combustion of this fuel than when charcoal is consumed. This necessitates the use of a somewhat larger scrubbing plant. The ordinary type of scrubber liquids which are obtained will soon pay for the cost of the alterations effected.

IN conclusion, it is desirable to point out that the utilisation of peat has attained considerable dimensions in other countries and that much of the work has long ago passed the experimental stage. While undue optimism in Malaya is to be deprecated, failures which have occurred in the utilisation of peat in Ireland should not be considered too seriously. Messrs. Crossley of Manchester have erected and worked large plants for the gasification of peat; in one particular instance, the installation is used for the production of power for a central electric distributing station. It is accepted that, with gas engines running at 70 per cent. of their full load, one ton of dry peat will produce 1,000 B.H.P. By a rough approximation, it can be seen that an acre of wet peat is capable of producing one and a half million units of electricity.

Cattle.

Cattle.

MALAYA possesses no distinct breed of domesticated cattle indigenous to the country, the stock found being of Indian or Siamese breeds, or crosses between the two. Some of the latter are excellent animals, but the majority of them are poor. This is due largely to their being inbred, and to their having been starved as calves.

THE system of breeding is at fault. The cattle are in small herds as a rule; and, as the males are not castrated until they are at least two years old, a large amount of inbreeding takes place, with the result that the stock becomes more and more degenerate.

Indian Cattle. Large numbers of bulls and bullocks are imported every year for draught purposes, and consist mainly of good specimens of the various breeds found in South India. They are large animals, mostly grey or white in colour, and are very useful for draught work. The climate of Malaya appears to suit them, as with reasonable care they continue to do useful work for a number of years. Some of the breeds, on account of their hard feet and quick gait, are especially useful for road work, while others are better suited for estate work. These cattle are very little used for cultivation work on estates, the smaller Siamese breed being more popular in this respect. A number of cows and heifers of Multan, Ongole, Hansi and other breeds of milch cattle are imported annually, and are bought by Indians usually at high prices. The price varies with the yield of milk.

Siamese Cattle. A large number of Siamese cattle are imported annually for draught purposes, and many more for slaughtering. These cattle are small, compact animals, mostly red in colour, and very useful for all kinds of draught work: they are excellent for road work and for cultivation work on estates.

A number of cows and heifers are imported from time to time, but they are poor milkers and are not greatly in demand.

European Cattle. Cattle of European breeds, chiefly short-horns, have been imported at various times, but the climate does not suit them. They require special attention as regards feeding, protection from diseases, and protection from the sun. As a rule, the cows do not keep up their reputation as milkers, and bulls become less fecund. As an upgrading factor they are an undoubted success. Cross-bred calves shew a distinct improvement in every respect: the male calves become bigger and more powerful animals than either of the parents, and are excellent as draught animals and as beef producers; the heifers become much better dairy animals than the pure Asiatic cows. If these cross-bred animals were used regularly for stud purposes, the class of cattle raised in the country would very soon shew a distinct improvement.

Buffalo. Throughout the country, there are large numbers of water buffalo or "kerbau." They are too slow to be useful for road work; but for the cultivation of padi land, for which purpose they are largely used, they are excellent and could not be replaced by any other animal.

They are also used largely by Chinese to drag heavy timber from the jungle, and for this work they are eminently suitable.

THERE are two distinct breeds in the country, differing in size and shape. One is a large-boned, heavy, gaunt animal, capable of pulling a heavy load, while the other is a much smaller but compact animal of a beef type. The cows give a small amount of milk, rich in butter fat, but they are used for breeding purposes only and not as dairy animals.

IN the neighbourhood of practically every town are to be found a number of Delhi buffalo. These are large in size, with deep wide frames and short thick legs. The horns are very characteristic, being thick at the base, inclining backwards and upwards, and then curling up in two or three coils. They are kept by Indians, purely for dairy purposes, and supply a large proportion of the fresh milk sold to natives.

Beef. Siamese cattle provide the greater proportion of the fresh meat in the markets. These cattle, with their compact frames and small bones, kill well and provide a large quantity of meat of excellent quality. The meat produced by Indian cattle is not so succulent as a rule, being provided by animals which usually have been at work for some time. Buffalo meat, which is a regular article in the market, is dark in colour and scarcely as palatable as Siamese meat.

Milk. For the most part, milk production is in the hands of Indians. Many of these have herds of excellent Indian cows, of which they take considerable care. Unfortunately, little attention is paid to proper breeding, with the result

that no improvement in the yield of milk per animal is obtained. The lack of suitable grazing ground in the neighbourhood of towns interferes seriously with extensive dairying.

INDIAN cows in this country give, on an average, eight to ten lbs. of milk a day, with occasional cows giving up to twenty-five lbs. a day in the early part of their lactation period. The milk is rich in butter fat, the average being about 5 per cent. Delhi buffaloes give a considerably higher yield of milk than do Indian cows. On an average, the daily yield of milk is about fifteen lbs., with a butter fat content of 6 per cent. to 8 per cent.

THE extent of adulteration of milk in this country is considerable. Water is generally used, but lime water and occasionally flour are used to improve the appearance of diluted milk.

Feeding. No attention has yet been paid to the laying down of good pastures, or to the growing of suitable fodder crops for cattle food. A number of varieties of good forage grasses are to be found growing wild in various parts of the country, and a few private individuals grow small patches of Guinea grass and similar fodder crops. The introduction of new fodder crops is desirable. THERE are many "kerbau" grazing grounds throughout the country, but the grass is largely lalang and a few poor natural grasses. On such pastures, buffalo thrive reasonably well but cattle, especially dairy stock, do not thrive well. Draught bullocks are usually given a supply of grass cut from the

roadsides and from waste land; but, to keep them in good working condition, the owners have to feed them liberally with concentrated feed. If this is not done, the cattle are miserable in appearance and are more subject to disease. The buffaloes used by Malays for padi cultivation find sufficient nutriment in the coarse grasses in their pastures, and in the soft water grasses which grow in the rice fields.

GENERALLY, no attention is given to calves. They are allowed to draw a small amount of milk from their mothers, and are expected to thrive on the coarse grasses they find. The result is that they are always lean and stunted in growth, and take a long time to reach maturity.

Poultry.

Poultry.

IN Malaya, as in most other countries, there is probably no subject of controversy so eagerly maintained, so difficult to solve, as that of Poultry. The scope for rival tastes regarding breeds, particularly between "Show" and "Utility"; the absence of any final word on feeding; and the ignorance of rearers, as distinct from breeders; each assists in adding to the length and fierceness of the controversy.

PROGRESS in the production of pure-bred poultry, though rapid during the last few years, has been confined to Europeans only; so far as the native population is concerned, poultry is of almost negligible value. The village "mongrel," fed almost exclusively on unhusked rice and allowed to roam unguarded, is thoroughly unsatisfactory, both as an egg and meat producer. They are not lacking in numbers, but there is infinite scope for improvement in their quality.

EVEN among Europeans, there remains considerable room for education, while insufficient protection results in frequent losses by theft. The number of actual breeders is small, most people being content with birds imported from England or Australia. That local breeding can be successfully accomplished is clear from the fact that, at the Malayan Agri-Horticultural Association's Show, held at Kuala Lumpur, in June, 1923, some locally-bred birds won prizes in competition with high-priced imported

birds. Improvement should eventually be accomplished by the local breeding of large numbers of pure-breds, encouraged and stimulated by frequent and reliable poultry-shows, for the education and enlightenment of the native poultry breeder by demonstration and effect.

Breeds. This country has its own variety of fowl, namely, the Malayan game fowl: it is characterised by a walnut-like, close fitting comb, broad head with beetle brow, long, straight limbs, wide shoulders, sloping back, with the tail carried rather low, giving three distinct curves—neck, back, and tail. The feathers are free from lacing and spangling, and are narrow and short, causing the bird to look lighter in weight than many of our English varieties, with which it compares quite favourably, however, when placed on the scale. The Malayan game fowl, of which over forty were exhibited at the Crystal Palace Poultry Show in 1921, has been considerably improved in the hands of English fanciers; but good specimens are rare in this country.

Of imported breeds, the Rhode Island Red is easily the favourite, followed by Utility Black Orpingtons, Plymouth Rocks, and White Leghorns. The Rhode Island Red would appear to be particularly suited to this country, being very hardy, and comparatively easy to rear; the hens are good layers, and make good table birds.

It is, however, impossible to give reliable figures as to the laying capacities of various hens in this country, since laying competitions have never been held in Malaya. The time is, however, considered ripe for their introduction.

Housing. As much attention should be paid to the proper housing of fowls in the tropics as in more temperate zones. The house should be dry, light and airy, but free from draughts and the upper part of one side, preferably facing south, should be wired. Three to four square feet of ground space should be allowed per bird, and the floor should be raised slightly above the ordinary soil level, in order to avoid dampness. Perches should be about two feet from the ground and on one level; below each perch, there should be a board or piece of old sheet-iron, covered with soil or lime, to catch the droppings. These boards should be cleaned regularly, and the manure used in the garden. The main floor should be covered with six to eight inches of old leaves or cut grass changed every three months; the evening grain, scattered into this litter, provides healthy exercise for the birds.

INTERNAL nest-boxes may be constructed in the form of shelves, the lowest being two feet from the floor, and the next one foot above. A three-inch strip along the front, and partitions one foot apart, complete the boxes, in which the nesting material will remain without difficulty.

HENS should be provided with a dust-bath, consisting of a box of fine, dry soil, or soil and wood-ash. If this is not provided, the hens usually find a substitute in a flower-bed, to the detriment of the garden.

AN important factor to remember in poultry-breeding is the necessity of segregating all undesirable

cockerels; these should therefore be either caponised or housed separately. For breeding purposes, in all varieties, one male should be allowed to run with four females, if fertility is to be maintained. If eggs are not required for hatching purposes, male birds should not be allowed to run with the hens, for infertile eggs have superior preserving qualities.

Feeding. There exists a considerable difference of opinion as regards the feeding of poultry; some advocate dry mash, others advocate wet. Dry mash, though possessing undoubted advantages in many respects, e.g. saving of labour, is unsuited to a climate like that of Malaya, in which it rapidly gets damp and stale, thus introducing bowel-diseases. The high mortality among native poultry is undoubtedly due largely to improper feeding, no attempt being made to supply a balanced ration. Among Europeans, there has long been felt the necessity for a balanced ration composed of locally-grown ingredients. Imported foods are available, but are considered expensive. Owing to lack of information on the chemical constitution of local foodstuffs, it has been impossible, so far, to recommend any locally-produced balanced ration; for the present, therefore, the use of imported foods (e.g., equal parts of wheat, maize, and oats) is recommended, while the necessity for analysis and trial of locally-grown foods is of the utmost importance. Such investigation are now being carried out at the Department of Agriculture.

GREEN food also is necessary, especially when the birds are confined; lawn-clippings, garden weeds, and bruised fruit are all suitable. Grit should also be supplied freely, preferably with the addition of 10 per cent. of crushed charcoal.

BIRDS kept in runs should be given 2½ ozs. of mash per bird at about 7 a.m., green food and household scraps at about 1 p.m., and 2½ ozs. of grain at about 6 p.m.

Diseases. A large pinch of Epsom salts is an effective remedy for many ills, and should be given if the bird begins to be lazy and has loose feathers. If the bird is not feeding well, an addition of chopped onions tends to make the food more appetising; in fact, if plenty of chopped onions are fed from the time when chickens are two weeks old, they will be protected from worms and from colds.

SINCE intestinal worms utilise the nourishment of their host they should be destroyed as quickly as possible; otherwise the birds will gradually become weak, and thus be more liable to cold, roup and other diseases common to poultry.

THE most suitable method of treatment is to withhold the evening feed in order to keep the intestines empty, and next morning to give a pill containing one grain of santonine and five grains of arecanut to each adult bird. This should be followed by a hot meal of bread soaked in hot water at about 4 p.m. the same day. Five drops of chenopodium oil in a teaspoonful of castor oil is equally effective. THE birds should be confined for 24 hours on cement or board floors sprinkled with lime so that all the worms expelled may be easily removed.

IN the tropics it is advisable to treat chicks for worms when they are from 4 to 6 weeks old, and again about 3 months later; otherwise they may die before they are 6 months old. Only ¼ to ½ of the above dose should be administered in the case of chickens.

Hatching. For hatching purposes in the tropics, either broody hens or incubators are suitable. Eggs for hatching by either method should not be more than seven days old. If broody hens are used, care should be taken that the hen has no more eggs than she can conveniently cover in order to prevent loss by chilling. As the chicks appear, their shells should be removed from the nest. A suitable material for nesting can be made from lalang grass, together with a few tobacco leaves, the latter serving to keep away lice and similar pests.

Care and Feeding of Chicks. There is no necessity to feed chicks until 48 hours after hatching, since they can exist on the legacy left them in the yolk; they are, in fact, preferably left until all the yolk has been absorbed. Since hens in this country tend to roam, the hen and chicks should be kept for the first week in a coop, so constructed that the chicks may roam at will while the hen is confined. The coop must be kept dry and should be closed at night to prevent rats from entering. Young chicks should be kept off damp grass in the early morning.

FROM the third to the seventh day, chicks should be given a good supply of grit, e.g. crushed egg-shells, and fed on oatmeal, biscuit-crumbs, and stale bread. Food should be given frequently, in small quantities at a time. After the first week, egg-shells should not be given, but should be replaced by other forms of grit; while crushed wheat or maize may be substituted for oatmeal etc. White ants are a very useful addition. "Kambu" (Grey Millet) makes very good chick-food, and is obtainable from most native shops.

CONSTANT attention should be given to the water-supply, which must be always cool and clean. Fountains are not to be recommended, since the water, though apparently clean, is not changed sufficiently frequently, and so tends to become stale. The water may, with advantage, be occasionally tinted with potassium permanganate.

THE hen should be taken from her chicks when they are about three weeks old, to prevent the coop from becoming overheated at night, and so causing colds. Chicks should, moreover, not be allowed to perch with the adults until they are six month old, since perching often twists the soft breast-bone.

COCKERELS should be removed from pullets as soon as they can be recognised; unless wanted for breeding purposes, they should be fattened for the table, and should preferably be caponised.

Conclusion. The question of improving poultry in Malaya is one that must soon attract the attention of Government. The recently-formed Malayan Agri-Horticultural Association, by holding frequent Shows all over the Peninsula, encourages, but cannot enforce or guarantee, improvement. The Asiatic is difficult to move in such matters; he will stare open-mouthed at the excellent birds exhibited by Europeans, yet is not prepared to feed and take proper care of his own; his ignorance could be easily overcome—his apathy is a far more difficult problem.

AS for the aged controversy between "Show" and "Utility," when regarded from the agricultural viewpoint, one can but say. "The hen that lays is the hen that pays."

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